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Heredity, Food, and Environment
in
THE NUTRITION OF
INFANTS AND CHILDREN

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PREFACE

The study of nutrition is both an engaging and fascinating one and is of the utmost importance in the preservation of health and in the prevention and treatment of disease. This may be more readily understood when one recalls that the source of all energy necessary to the health and activity of infants and children is dependent on the chemical nutrients of the digested foods which surround and enter the body cells. A clear conception of foods, of their nutrients, and of their behavior in the body is therefore of paramount importance, and an acquisition of their knowledge will lead to far-reaching and amazing results. That the average person possesses but a rudimentary and often fragmentary understanding of the principles underlying nutrition, is evidenced by the lack of discretion shown in the selection and preparation of foods and in the poor judgment employed in serving them at the proper time. Because of the traditional credulity on the part of the public, innovations in the form of "popular foods" and infant food formulæ are accepted without challenge from pseudo food specialists, food products manufacturers, from inexperienced investigators, and from certain cults, who inculcate in the minds of the laity a faulty idea as to what constitutes nutrition. Although these foods have usually only a shortlived popularity and are sooner or later discarded, such sources of information tend to divert the minds of the public, and the efforts of gifted physiologists and biochemists often pass unrewarded.

The public is not wholly at fault, for certain medical schools and other institutions, as well as many books and periodicals dealing with foods and their chemistry, have failed to include in their curricula and pages a broad understanding of nutrition and of the physical, psychic, and other environmental factors which contribute to it.

The transmission of variants, modifications, variations and mutations, traits, etc., and the effects of hybridization, inbreeding, and cross breeding tend to change, upset, and modify disease types and add to the growing organism dysfunctions and potentialities, often different from those of the parental and ancestral stock. Many characteristics overlap, making diagnosis obscure and treatment and prognosis often difficult.

In the breeding of animals, heredity, the inheritance of potentialities, traits, and other characteristics, as well as nutrition and environment, are taken seriously into consideration. No such measures have been undertaken in the same systematic manner in the breeding, nutrition, and rearing of children. Indeed there is a tendency to study infant nutrition from the standpoint of foods alone, and not to include environmental stimuli, to overemphasize certain foods and their characteristics, to feed infants and children in groups rather than individually, and to follow blindly inconclusive theories and inexperienced leaders rather than to work out nutritional problems from research and observation.

It is not possible within the limitation of these pages to enumerate all the foods and environmental factors necessary to the balancing of metabolism, but it is hoped that enough has been said to contribute sufficient knowledge of the fundamental principles of nutrition and of its motivation to provide an effectual groundwork for the preparation of rations suitable for the maintenance of health and for the prevention and cure of nutritional disease in children.

Indeed, no biologic detail of whatever kind or character is so obscure, so remote or unrecognized, that it cannot in some manner fit into the warp and woof of the human structure.

This volume tries to clarify the origin of hereditary and somatic disease, and in general to enumerate the foods and methods used in preventing and curing them.

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CHAPTER I

HEREDITY AND ENVIRONMENT

CONSTITUTION AND CONDITION

Before beginning the study of heredity and of its associate, environment, in relation to the cause and treatment of disease, it is well to understand two expressions used by athletic mentors and pediatricians alike in their various duties and responsibilities; namely, *constitution* and *condition*. The former emphasizes heredity; the latter, environment. The normal balance between constitution and condition denotes health; and unbalance, sickness or death. A study of constitution alone stresses the individuality of each person as well as the structural and functional differences that distinguish persons from each other.[1] The fertilized egg cell, or cosperm, through its chromatin represents inheritance uninfluenced by environment. Sooner or later it begins to be influenced by its surroundings, by substances and energies; in other words, to undergo changes. If development proceeds normally, the reaction between plasm and environment gradually leads to the fully developed organism of adulthood. This developed organism we term the phenotype; the germinal material with all its hereditary peculiarities we call the idiotype or genotype, since it contains the elements that determine the reactions which give rise to the characters of the later developed organism. This idiotype, which is due to heredity, may be called constitution; the rest of the phenotype is the result of the constitutional factors with conditional influences. We speak of the constitution of a child as of a certain type, according to his bodily and even his mental characteristics.

Therefore allied with constitution, but not wholly akin to it, is that phase of life which is called condition. Constitution is purely hereditary in character, while condition is purely environmental. Condition includes those qualities which are acquired during development and in the course of the child's life. Such environmental factors include food environment, geographical location, education, social position, certain diseases, etc.; qualities which are not transferable to the offspring and which are not represented in the germ plasm. The child is studied as a unit. We study also his anatomical make-up and the functional

activities of the many organic systems as well as the regulatory mechanism that controls and integrates them. As clinicians, we regard as normal a child whose vital responses correspond completely to those biologic needs which depend upon their correlation with a physical, chemical, psychic, and social environment.[1]

Constitution, as we have said, emphasizes the individuality of each person, the structural and functional differences that distinguish him from another. Each child is different from another, even though of the same strain, age, and environment. These variations are passed on from one generation to another, for they are definite in character. Similar pictures are seen in the differences between plants of the same species. In general appearance all seem to be similar, but on closer inspection they differ in detail, in color, structure, etc.[2]

A child's normal healthy life may be said to be a harmonious balance between its internal relation, or constitution, and its external relation, or condition. Herbert Spencer defined life as the continuous adjustment of these internal and external relations. He might have added that disease was a declaration of a maladjustment between these forces.

Among such external relations, the universe supplies not only sustenance and other vital needs of the living organism, but also directs injurious pressure upon it. This pressure may be physical, chemical, bacterial, or psychic. Obviously the more violent a pressure becomes and the more difficult it is to resist, the simpler it is to recognize it as a cause of ill health. Diseases, therefore, are essentially sets of observable phenomena which recur with sufficient regularity to form entities for the pediatrician. Their symptoms and signs express the conflict between the unique inherent "internal" relations of the child and the extrinsic or "external" relations of its particular environment. Instead of employing the words *constitution* and *condition* we unconsciously visualize their harmony in the expression *vigor* and their maladjustment in the expression *weakness*.[3]

Even in the immature child, pediatricians recognize a weak, muscular, or athletic type, a short, a stout, or a thin type, and many others. But we must admit of a truer classification into certain types in adulthood, because of the maturity of the transmitted characters or of the transmission and maturing of organic potentialities. Convincing it is, says Loeb, that certain bodily structures predispose to specific diseases. In many instances such constitutions are inherited, and with them certain disease potentialities.[4]

VIGOR: ESTABLISHMENT IN THE CHILD

By vigor is meant the reaction of nutrition and function; in other words, it is a state of high metabolism. When this rate of metabolism is greater in one child than in another, the vigor is said to be higher. Take two clocks, for example; in one, the ticking is twice as fast as in the other, but the hands of each do the same work at the same time. Internally, the mechanism of the one works at double the rate of the other. Such a parallel is seen in the lives of children. Each one of a group of children performs similar functions, eats and sleeps, plays and rests, but the metabolism of the one may be twice as active as that of another. Up to the present moment, no method of certainty is known for measuring the rate of metabolism except from the child's actions, from his color, etc. However, pediatricians get a very fair idea of the vigor of the child from his physical and mental reactions.[3]

This vigor, being at its inception constitutional, has its first and strongest initiative in the vigor of the parents and in the combination of their respective constitutions which are transmitted to the child. This might well be termed "initial vigor." It is that form with which the infant starts life before the effects of an external environment are manifest. This united vigor in the parents depends naturally on their rate of metabolism at the time of copulation, and its rate will depend upon their initial vigor modified by their environment. If two parents have the same vigor, their offspring will be of that vigor. Also, if the vigor of both these parents be raised to the same extent by favorable conditions, their second offspring will have a higher initial vigor than the first. If, then, children are born to parents at their highest peak of vigor, such offspring will have a higher initial energy and will be always capable, under suitable environment, of reaching even a higher peak of physical power than was possible to either parent or to any other offspring born when the parents' vigor was lower.

Thus it follows that a rise of vigor in the parents, brought about by favorable internal and external conditions, is, to a certain extent, passed on to the offspring of the first generation, and if the conditions remain stable and favorable, it is inherited by the infants of the second generation. If, on the other hand, this vigor of the two parents be widely different, then the initial vigor of the newborn will be intermediate between that of the two parents, in short, a blend.

If the constitution of both parents is at low ebb, particularly

at the time of copulation, the initial strength of the newborn infant may be weak and pitiful.[5] These conclusions, it would seem, might well turn our minds to those thoughts expressed under infant mortality. In truth, Greenwood and Brown, after extensive study, did ascribe a high infant mortality rate to the excessive breeding of pathologically inferior stocks.

There are, at times, both in the parents and in the child, marked fluctuations of vigor due to climatic changes, such as humidity, also to the quality and quantity of their food. In the child an excessive accumulation of fat is an index of a sluggish metabolism, a condition of low physical force. Fat, however, being reserve material, may also arise primarily from an excess of foods, especially if accompanied by only moderate vigor.[7]

Animals accumulate fat in the autumn, as food is then easy to get. Extreme cold induces a sluggish metabolism in these animals, and they hibernate. Many children tend to do the same thing. On the other hand, in the spring, with higher temperatures and a more plentiful food supply than is found in winter, there usually follows, at least in animals, a higher state of vigor. Vigor may truly be compared to steam pressure in a boiler, which must express itself in some form of energy, and the higher the pressure, the greater the energy.

ENERGY

Nature has several ways of expressing energy. The outward expression of energy is seen in different animals as different colors. Restless energy is shown in the children by outbursts of song, in play, exercise of all kinds, enjoyable mental activities, by protestation against disciplinary restraint. Nature has other methods for reducing the pressure. Instead of taking coal from the furnace she reduces the food supply and applies cold, else the pressure would go on rising. However, in increasing the rate of metabolism (vigor), nutrition alone is not sufficient, for there must be different instrumental factors involved, such as play, sunshine, bathing, and a host of others.

Even the fertility of an animal or of a human being is dependent largely upon constitutional vigor as well as upon conditional environment, for the latter can exert such a strong pressure upon the individual that the outcome will be either the health, the disease, or the death of fertility.[6] The differences of power in fertility which is passed on to succeeding generations must be greatly, if not entirely, due to the vigor of the parents.

HEREDITY IN GENERAL

It would be an Utopian existence could the pediatrician, through nutrition, save all his little patients, and bring each one to normal health and happiness. Unfortunately the sins of the fathers will ever be visited upon the children down the generations, and these sins act as a distinct handicap to our endeavors. In order to understand why some infants and children die, why others get well under the most adverse environmental conditions, why some unfortunates are seen with malformations of one kind or another, we must study carefully and patiently, interpreting wisely all the knowledge which research workers have given us. To recognize fully how to treat nutritional diseases one must know equally well how to diagnose them and in order to diagnose them one is often forced to seek information from the dead. Probably no science is less understood today in the immensity of its details or in the wisdom of its teachings than is heredity, and it instigates an enormous number of misconceptions. Before we can even approach the general subject of disease and its treatment, we must, perforce, recognize the principles of heredity and be able to translate them in terms of disease.

If one painstakingly keeps to his road, he may be able later to shed light upon the unrecognized causation of disease, of disease manifestations, and also upon the reasons for excessive infant mortality and for the ill health mentally and physically of children. There is in reality a natural biological interpretation of the transmission of characters in health and also in disease.

This is not always a simple matter, for in the higher animals heredity can be recognized only as a result of some physiologic process. True, the inherited character is not of itself a physiologic one, but is a structure produced by some physiologic activity, a circumstance which is not always true in the lower animals. In the higher animals, the humans, the characters are handed from parent to offspring fully formed and in the same condition in which the character will appear in the infant when it becomes an adult, for the completeness of characters is only seen in maturity. In the higher animals, however, there is never any such direct transmission without a change from one generation to another. In more complex organisms, such individuals start their existence as an undifferentiated bit of living matter. Something, therefore, must be present in this earliest bit of living matter which will cause certain characters to develop.

OLDER VIEWS ON HEREDITY

A study of the black art, of old superstitions and customs, of the enslaving power of religious dogmatism, and of the ignorance of biologic activities, etc., reveals the great mass of misinformation supplied to the people of long past generations and which, even at the present time, is still wide spread. Strange ideas out of the dim past frequently appear to harass the pediatrician. In tracing the causation of disease through heredity, and in the treatment of it through nutrition and environment, he thinks in modern terms. The old Calvinistic point of view was that misfortune came in the guise of disease, as malformations and mental defects in infancy and childhood, and the older pediatricians were content with the philosophy that such things were the Creator's will. Nowadays the physician, instead of feeling a woeful irresponsibility and accepting unquestioningly the will of a Higher Power, looks at the matter from a more scientific angle and sees either a morbid tendency in the strain or some evidence of somatic neglect or ignorance. Particularly in mental diseases and physical abnormalities do we scan the ancestry in no forgiving mood.[7]

From a study of the ancient writings of the Chinese, we find that eugenics cropped up, for there is shown a deliberate attempt to preserve the best in the human race. At least they possessed a conception of what heredity stood for. Aristotle, in the fourth century before Christ, recognized the crossing of strains as a means of obtaining a knowledge of heredity.

He also noticed the phenomenon of skipping a generation, so characteristic of what we now know as recessive characters. Certain experiments were even carried on in the plant kingdom somewhat later. In the seventeenth century, tulips and hyacinths were scientifically developed, but with very little insight into the biologic results, the experimental data being unfinished and so inconclusive. In 1694, Camerarius, a German teacher of natural history, suggested crossing certain varieties of plants, but unfortunately he lacked the energy and initiative to carry out these suggestions. Other research workers carried on experiments which were left unpublished. About 1769, at the University of Louvain, experiments were made on peas and other plants.

That period produced also Francis Galton, the earliest investigator of human heredity, but he dealt with characters exceedingly variable. His idea of heredity was the degree of likeness between the parents and their offspring, and he was greatly con-

cerned in the improvement of the family and of racial characteristics. The word eugenics was coined by him.[8]

The study of the origin of disease in man is not of recent growth. More than three thousand years ago Moses described such an origin when, in depicting the beginning of the Universe, he records the first punishment in these words, "And I will put enmity between thee and the woman, and between thy seed and her seed."

Aristotle was indeed the first to conceive of a genetic series, and his conception of a single chain of evolution from polyp to man was never fully replaced until the beginning of this century. He perceived the forces of prepotency and of atavism, or reversion to type. Of prepotency he said, "Children resemble their parents not only in congenital characters but in those acquired later in life." But in the inheritance of normal functional modifications he did not believe. Some of the most fantastic ideas of early observers are expressed in the theory of telegony or impregnation, which was formulated about 1530, from the observations of Forsilloux, and even Darwin and Spencer reported instances of what they considered telegony. The explanation was based on the theory that the first male made a profound impression of a nervous nature on the unformed or forming cells of the ovary, so that all subsequent offspring were affected. The theory of impregnation of an ovum while still in the ovary was advanced. While in the uterus, the first fetus was also believed to produce a lasting influence on all later formed ova. This theory is both false and fanciful, yet as late as 1921 it attracted more than passing notice at the French Academy. What pediatrician has not encountered such ideas through living in the countries of Southern Europe, or in treating the foreign born from those countries in his clinic?

Finally the theory of the relationship of environment to the mutability of species was originated by Buffon (1707-1788). In his *Histoire Naturelle* he said, "In animals, species are separated by a gap which nature cannot bridge over, we see him dictating his simple but beautiful laws and impressing upon each species its immutable characters."

In 1761 he added, "How many species being perfected or degenerated by the great changes on land and sea, by the favors or disfavors of nature, by food, by the prolonged influence of climate, contrary or favorable, are no longer what they formerly were?" Later, he again added, "One is surprised at the rapidity with which species vary and the facility with which they lose their primitive characteristics in assuming new forms."

In our attempt to trace both the acute and the chronic forms of disease from hereditary sources and to show that many of them can be eradicated or modified by environment, we cannot afford to neglect Diderot (1713-1784), who discussed the origin of man in these words, "Even if Revelation teaches us that species left the hand of the Creator as they now are, the philosopher who gives himself up to conjecture comes to the conclusion that life has always had its elements scattered in the mass of organic matter; that it finally came about that these elements united; that the embryo formed by this union has passed through an infinitude of organization and development; that it has acquired in succession, movement, sensation, ideas, thoughts, reflection, conscience, emotions, signs, gestures, articulations, language, laws, sciences, and art; that millions of years have elapsed since each of these phases of development and that there are still new developments to be taken which are as yet unknown to us." [9] He certainly proved a good prophet.

MODERN IDEAS OF HEREDITY

The modern science of heredity, in its biologic, but not in its human pathologic aspect, dates back to an Austro-Silesian monk by the name of Johann Gregor Mendel.[9] This man, through his standardization of the principles of heredity, has added greatly to the knowledge of the biologist. Mendel, working in his garden plot at the Abbey of Bruenn, showed all the essential laws of heredity through carefully conducted experiments. The eminent botanists, Tschermak, Correus, and Devries, found and read his publications sixteen years after his death and thirty-five years after the publication of his work.

For his first experiments Mendel chose the common garden pea or *pisum sativum* because its flowers are self-fertilized. The stamens and pistils are enclosed in the keel of the flower and only rarely can cross-fertilization be accomplished by insects. This cross-fertilization, however, was brought about by dusting the desired pollen on the chosen pistil. Mendel selected first several pairs of characters and watched their recurrence in the succeeding generations. Two varieties of pea were first crossed, each of which held true, the one producing plants about six feet high, the other gaining a height of one and one half feet. He found that the hybrids were all tall; therefore, he called the tallness the dominant character; and dwarfedness, the recessive one.

In the next generation, the progeny of the hybrids showed the

proportion of three talls to one dwarf. The dwarfs on further breeding, bred pure; one third of the talls bred pure also; but two thirds of the talls on rebreeding still produced one fourth pure talls, one half impure talls, and one fourth dwarfs. Thus, if one parent carry, for instance, the dominant character "D," the other, the recessive character "R," the hybrids have the form "D R," and as the dominant character is present they will resemble it, the tall parent. However, when "D R" and "D R" are mated, there are three possibilities arising and the one is twice as probable as the other two. Thus in the second filial generation, the formula will be "D D";—2 "R R";—"R R." While the subject matter is rather obscure and confusing, it is well to hold the main points in mind, as it aids in understanding the succeeding pages.

In human heredity, the resultant individual from the union of two sex cells is termed a zygote. When the zygote is pure for its specific character it is termed a homozygote; when impure, a heterozygote. The crossing of the latter with recessiveness will result in fifty percent "D R" plus fifty percent "R R." The crossing of heterozygotes with homozygotic dominants will result in fifty percent "D D" and fifty percent "D R." [10]

"Modern studies in genetics," says Conklin, "are emphasizing the immense and overwhelming importance of heredity in both the ancestral history of the individual and in his subsequent development."

The belief in the omnipotence of environment in the evolution of the species has, in recent years, been waning. However, it must be said that a belief in the mutation theory and in orthogenesis has been increased. In truth, neither heredity nor environment are all-important in themselves and the one cannot fulfill its mission without the other. While changes in environmental conditions do influence modifications in the adult organism, yet such modifications are much greater when a responsive environment acts upon the organism during the period of the child's development.[11]

Since man is slow in breeding and a polyhybrid with but few children, he is a relatively poor subject for experimentation. Experiments on humans are less satisfactory, less accurate than those on the lower animals. However, these experiments run somewhat parallel courses, for in man as well as in animals the cellular theory is the basis of heredity. In man as in animals there is the same distinction between germ cells and soma cells.[1] The general principles of heredity and development in the animal are broadly applicable to man. However, human inherit-

ance must be studied by methods somewhat different from those which are employed in the case of domesticated animals and plants. Controlled matings are manifestly impossible and data must be accumulated by the less exact method of analyzing family histories.

The science of genetics deals with heredity, the mechanism by which resemblance between parent and offspring is conserved and transmitted; and with variation, the mechanism by which such resemblance is modified and transformed. Genetics is founded on the two laws of Mendel, the law of Segregation and the law of Independent Assortment and Recombination. Blue eyes mated to blue give only blue, or brown eyes mated to brown give only brown if the browns have only a brown-eyed ancestry as a dominant character. If brown eyes of a brown-eyed ancestry mate with blue eyes, then all the offspring will be brown-eyed. If, however, brown eyes with an ancestry including blue eyes are mated with blue eyes, then among their offspring browns and blues will occur in more or less equal numbers. This is a variation, but the blue and brown eyes are in these particular instances recessive in character.

The phenomenon of dominance is an unessential feature of Mendelian inheritance, for we are almost all hybrids of one kind or another. The understanding of these terms has a distinct bearing on our study of disease in infancy and childhood. The body build of protoplasmic cells has a definite shape and structure characteristic of the particular species of which the individual is a member. Each individual is the latest member of a long and uninterrupted succession of living things extending back generation after generation to the dawn of life.

Reproduction, the handing down of the essence of life in the more highly organized living forms, consists in the union of two specialized sex cells or gametes; the one, the egg elaborated by the female parent; the other, the sperm by the male, to form the fertilized egg or zygote, in which the new individual has its beginning. The zygote, specific to the highest degree, embodies all the possibilities of individual development, of health and disease, and of racial perpetuation. Each sexually distinct parent contributes but a single cell so minute as to be beyond the vision of the unaided eye, and yet through these gametes must pass everything organic from one generation to another. The zygote presents none of these characters which, when the individual has developed and differentiated, will enable the observer to classify and describe it, and yet in this combination of the gametes, the

fertilized egg, there must be much which predestines its morphologic, physiologic, and psychologic destiny, for it decides in great part the future characterization of the individual. Those qualities which are innate in the gametes alone are inherited. Like tends to beget like, and yet at the same time there is great dissimilarity. Every individual will exhibit sooner or later those details of structure and function which characterize the species, the race, even the family or strain to which he and his ancestors belong, and yet no two individuals are alike. Much of this variation is undoubtedly due to the impress of environment upon the developing body and mind.

Variations, dissimilarities in characters shown by related individuals, are of several kinds, and due to many causes: (1) They may be due to differences in environmental conditions, nutritional, climatic, and the like, being therefore acquired modifications. (2) They may be due to differences in hereditary constitution resulting from the scramble of hereditary factors in breeding, an expression of different combinations of hereditary factors. (3) There may be variations, dissimilarities due to mutation, to definite alteration of the hereditary constitution, the so-called "sports."

The first are due, as we have said, to environmental agencies, and are exogenous. The two others are endogenous or originating within the organism. The first are called paravariations and are not inherited, but are seen as differences between related individuals caused by environmental conditions, similar or dissimilar.[12] These variations may be classified according to the nature of their effects upon the organism as morphologic dissimilarities in size and form, physiologic differences in quality and function, psychologic variations in the mental make-up of individuals, and ecologic differences which result from their fixed relation to dissimilar habitats. Variations, again, may be continuous, fluctuating, or discontinuous. They may be chance variations leading nowhere in particular, or they may form a progressive series tending to a definite direction. In this study of variation, the important point is to decide whether the particular differences are of environmental or of endogenous origin. For example, a man might in respect to his eyes resemble his maternal uncle and not his parents. The curl of his hair might resemble that of his grandfather, his ability might come from his father or from ancestors. The conception of germ plasm, an indirect outgrowth of the "idioplasm" of Nageli and others, was first skilfully handled by Mendel, who collected critical data and placed

them in order, and then constructed a tentative explanation for this order. He also tested his hypothesis by further careful experimentation.[12]

COMPARISON OF PLANT AND HUMAN INHERITANCE

Man has patiently but progressively tried to cross the gulf from plant and animal experimentation to human heredity and is now succeeding. While in plants a notable proportion of pollen grains engage in mutual fertilization, this number of ova has never been found in the higher animals. In human beings, even when a pair are very prolific, having, for example, from six to ten offspring, this number is small when compared with the number of ova which actually ripen. In the human female, during her reproductive period, the number of ova to ripen averages 360.[8]

THE THEORY OF THE GERM PLASM

The theory of the germ plasm takes into consideration the existence of a number of individual particles of substance, pepper seeds, one may call them, each of which controls the development of some particular tissue or character in the developing individual. It does not require, however, that these particles be concerned wholly with heredity transmission. For the formation of a character the individual must receive two factors through the gametes, one from each parent, which are either similar or dissimilar from those of its parents, according to whether or not the parents were alike or different. When the individual elaborates his reproductive cells, into each ripe gamete there can pass one or another but not both of these factors.

The zygote may be hybrid in respect to a character or characters, since one or more pairs of factors may include dissimilar mates; the gametes cannot be hybrid, since they are simple as to factors. Again, this theory contends that the association of dissimilar factors within the zygote is not attended by any adulteration of them. Mendel put forth the theory that each gamete carries a factor for each heritable character that the future individual may exhibit. Some characters are dominant, being handed down to the individual from dominant characters in the strain of the mother and of the father, dominant alike in structure and function.

A brown-eyed offspring can have received these factors for this character from both parents. Similarly any organ—nose,

ear, heart, liver, spleen, nervous system, structure of brain, etc., is affected as to size, form, and function from both parents. On the other hand, this brown-eyed infant may have received one factor for the brown-eye character by way of one of the gametes and one factor for blue eyes by way of the other. The infant will be brown-eyed because, for reasons unknown, brown eyes are dominant to the recessive or sleeping blue-eyed character.

Thus one can postulate that the size, structure, and function of the organs of the body of the newborn can be histologically and pathologically affected through the dominance and recessiveness of the two gametes in the *fertilized egg*, for *dominance* precedes *recessiveness.* It can also be postulated under certain conditions that certain organs of the child's body may be dominant as to growth impulse, in size, structure, and function, while others under dissimilar conditions may be recessive as to transmitted characters, pathological in fact, rendering the organism an unbalanced whole, with resultant death or infirmity.

If, of the two characters concerned in the union of the gametes, the determiners or heredity factors or genes which give rise to the individual, one is dominant and the other recessive, and if in any fertilization there are available equal numbers of ova carrying one or another of the factors for two alternative characters, and if besides there are equal numbers of spermatozoa carrying respectively one or other of the two same factors, and if fertilization is at random, chance will yield on the average, in every four, three individuals exhibiting the dominant character of the pair and one recessive. The pepper seed chromosomes themselves are in reality the bearers of the hereditary factors. These hereditary factors called genes are resident in the chromosomes, and upon each chromosome is borne a certain association of genes, and each gene or hereditary factor has its own particular place upon a particular chromosome.

While this subject of the inheritance of characters has been somewhat laboriously dealt with, we cannot but believe that much which has been said is necessary for the ground work, for the understanding of the transmission of malformations, unbalanced organs and structures, etc. In the fracture and the splitting up of the chromosomes or in the halving, doubling, or trebling of them in one parent cell and in their combination with the fracture particles of the chromosomes of the other parent cell, we can imagine all sorts of organic conditions. If, by way of illustration, we can imagine that the hereditary factors of the heart, liver, spleen existed in normal potentiality as to size, structure, and function in the chromosome of the mother and

they combine with unwholesome chromosome fragments of the father in the fertilized egg, is it not fair to assume that potential maladjustments might take place in the heart, liver, or spleen of the child as to size, structure, and function, with the resultant death, malformation, or infirmity of the offspring?

Can we not postulate similar conditions in other organs of the body, in fact in all organs and structures in the individual's make-up? On the other hand, a healthy and homogeneous combination might result in a strong constitution and in a potentiality for a long life. In short, every structure of the body is the end result of a long series of interacting processes, and if a modification steps in the end result in the series is seriously affected. If, in other words, these hereditary factors determine their characters through the physiologic action of their specific constitutions to the general economy of the developing *fertilized egg,* then changing a gene—a *mutant,* so-called—may lead to such alteration in this state that the development of the whole body is affected slightly and that of a particular organ is profoundly modified.

If the formation of characters is the end result of developmental processes and if the hereditary factors do influence these characters, then the latter factors do also influence developmental processes.[12] The ultimate product of the individual is not wholly determined by these hereditary factors in their multiform actions, for the development of the individual successfully or unsuccessfully imposes a tremendous power of action on the part of environmental agencies. Under the influence of suitable environment, the *fertilized egg-cell* develops stage by stage into adult form, and as the body develops there arise gradual transformations of simpler reactions and activities of the "oosperm" into extremely complex and varied reactions and activities which are seen as instincts, habits, and higher intelligence, which characterize maturity; for no characters assume their full dominance until this stage is reached.

The development of the child into manhood or womanhood is basically determined by heredity, but all his qualities of mind and body exist only in potential depths and must be modified, stimulated, or inhibited through "environment." Thus, we can say that species, characters, and racial characters are all inherited and are firmly fixed by heredity. Many individual characters, both structural and functional, are known to be inherited, says Barker, but some are undoubtedly due to environment and are not inherited. All possibilities for the development of the mind and body lie inherent in the germ plasm and the possibilities

which become realities in the developed adult are dependent upon "stimuli" originating in the surroundings.[1] Such physical stimuli acting from without all strongly affect the development of inherited characters. Such environmental stimuli produce their effects in three ways:—(1) They modify the development of inherited characters. (2) They condition the production of characters whose heredity determiners are present in the germ cell. (3) They may cause germinal variations which result in the appearance of new heritable characters.

Light, function, temperature, the food supply, and metabolism, all modify the development of such characters. Newman believes that such environment may create new heritable characters, in proof of which he cites the experiment of MacDougal. This biologist injected very dilute solutions of potassium iodide, zinc sulphate, sugar, etc., directly into the ovaries of various plants immediately before fertilization. Somatic changes were produced and inherited through several generations.[13] Physical and physiologic characters are more easily followed in inheritance than are mental characters, for the reason that they can be more readily recognized and measured.[9] Much more is known about the hereditary transmission of anatomical defects and of physiologic derangements than of normal characters.

In the human, there is a mechanism of inheritance exactly similar to that which is found in more thoroughly and critically studied forms of plant and lower animal life. Simple dominance, simple recessivity, multiple allelomorphs, and sex linkage can be paralleled in the human as well as in the lower forms. A number of transmitted characters are shown to be based on two or more pairs of multiple factors, and to exhibit, therefore, a blending type of inheritance which is so common in the case of an individual in respect to many inherited characters. Most of the different size characters, the different organs and structures of the body, favor this form of inheritance; and there are reasons for believing that certain types of bodily conformation, bodily unbalance being obviously the result, are closely associated with certain susceptibilities to disease. Size, however, is a growth phenomenon and depends not only on sexual maturity, in the causation of bone growth, but also on the time of functioning or on the amount of secretion of the endocrine glands.

These inter-relationships make the study of organ formation a matter of great difficulty. No race is pure, no inherited characters are pure from both parents, no organ or structure of the body is perfect, and there is no one hundred percent perfection in a single organ or in multiple organ balance. Should disease

be attached to one or more characters transmitted by both parents, it can be seen how perfectly unbalanced the individual can grow, with the possible fact of death or infirmity staring him in the face. However, diversity may step in and the transmission of a diseased character may be of such minor importance that the organism, balanced as a whole, considers it of small account.

The size, growth, structure, and functioning of the body organs are largely dependent on the glands of internal secretion and on nutritional agencies in general. It seems probable, however, that hereditary factors affect the size of the body as a whole and there are other factors which influence the size of local parts. Stature is not a unitary affair but is the result of many diverse inherited elements becoming expressed under a particular set of conditioning environmental agencies. Such stature may be dominant, recessive, or variant in character, and one can never prophesy. If both parents are tall, the chances are that the offspring will inherit the dominant characters for tallness. In the same way, similar characters in both parents for shortness, normal or abnormal conditions of the stomach, intestines, liver, spleen, nervous system, heart, lungs, etc., will probably be inherited. These conditions are influenced also by dominance in one parent and recessiveness in the other. Both parents may transmit dominant or recessive characters for disease or health which may result in the dominance of a character. Certain characters for health and disease may be so varied that their origin cannot be traced in the ancestry of either parent. The characters may be a recurrence of those existing several generations earlier, known as atavistic.

For purpose of illustration, if the four grandparents of a child be very unlike, this child or his brothers and sisters will be variable, whereas, if the four were similar in respect to height and constitution, we can assume that the grandchildren will tend to be like them. If the offspring inherit a dominant character for health from one parent and a character for disease from the other, some will be healthy and some diseased, other things being equal. Indeed, there are many racial variations in musculature and in the shape and size and functional capacity of the internal organs, even in the familial peculiarities and in the distribution of blood vessels and nerves.[12] These inherited differences as to size of organs and of body parts, including the brain, are of profound significance, because racial and other crossings can lead to serious dis-harmony. We can easily see what the crossings of the diseased and the healthy can bring about. Disharmony between teeth and jaws, between size of

body and size of some important organs, disharmony among the endocrines and their syndromes, can all result from pathologic transmission.[12]

Natural death of an infant or child would be impossible were all the conditions of good inheritance and good environment interlaced. The living cell is potentially immortal and would be immortal were such harmony provided. The germ cell is immortal and the various somatic cells and tissues have been shown to be potentially immortal in tissue culture. Tissues and organs die because of the differentiation and specialization of structure and function which they exhibit, for such specialization involves the loss of functional independence. The component parts of a child's body are so interlocked and so interdependent, that a break-down in one throws the whole mechanism of the others out of order. In fact, different organ systems, tissues, and structures wear out at different rates, for the reason that all the parts of the organism are not equally perfect. The probability of any particular organ system breaking down and causing death is mathematically definite at each age, and changes in an orderly manner as age advances. Thus, for example, a break-down in the respiratory system is responsible mainly for deaths occurring between the ages of one and sixty years. Over fifty per cent of these deaths result from a failure on the part of those organs of endodermal origin, or lower skin layers, such as the lining of the primitive intestine and its derivatives. About ten per cent are from a break-down of such organs as the hair follicles, enamel of the teeth, and similar structures known as ectodermal. The remaining deaths result from the failure of the mid-skin organs, the mesodermal, which give rise to the vascular, muscular, and skeletal systems and to the generative glands and kidneys. The endoderma is least fitted for the task of modern civilization.

In the study of health and disease in infancy and childhood, the pediatrician of necessity centers his mind on the secrets contained within the germ plasm. Within this body lie the mysteries of the transmission of well or ill being. The egg and the spermatozoon, in combination, contain this germ plasm which constitutes the sum of all the hereditary factors. These germ cells, after fertilization, develop into the embryo and, in time, into the full grown individual. The characters of the germ plasm, coming, therefore, partly from the mother and partly from the father, determine what kind of an embryo and what kind of a child will be produced.

At an early stage of development these fertilized germ cells

give origin in the embryo to new germ cells which later become the germ cells of the child. It can easily be seen that the germ cells form a continuous series from generation to generation. The united parent germ cells give rise to the next generation of germ cells in the offspring, these cells being the depository of germ plasm. This continuity of germ plasm is the basis of heredity in living organisms. It is equally true in plants, in animals, and in man. It is readily apparent that the biologic character of the germ plasm is the main factor which determines the structure and functions of the subsequent fully developed organism, but the germ cells themselves require environmental factors for their development. These factors may lie within the developing individual or his internal environment, or may be influences from the outer world, or outer environment. Certain internal environmental factors are needed by the germ plasm in order to produce specific structures and functions. Some of these environmental factors can be varied and sometimes even eliminated experimentally without endangering the life of the child, while others are relatively constant and unchangeable, as well as necessary, if life, growth, and development are to proceed.[4] Both the internal and external factors profoundly influence this course of development. If this were not the case, the eggs, for instance, of a starfish and of a sea-urchin respectively, lying side by side in a finger bowl, would not develop along entirely different lines after the first cleavage steps had been passed through. Indeed, even in the case of identical species, the course of development is not always the same. We have never found one child to be absolutely like another.[14]

The fact has been pointed out that the germ plasm derived from the fertilized egg cell is nothing more than a germ plasm cell. We may liken this germ plasm to a root creeping along under, from which shoots spring up and, in turn, become plants which correspond to the single human individuals of successive generations. Although the successive plants die one after another, the root keeps on giving new life.[15] Environment, in a word, can act upon the germ plasm through chemical influences, through the products of metabolism, and through specific internal secretions.[16]

THE CHROMOSOMES

Fertilization is the union of the egg of the female and the spermatozoon of the male. Within the germ cell is a spherical body called the nucleus, and within the nucleus is a network of

fibers and a kind of sap which fills the interstices of the network. This network resolves itself into a definite number of threads or rods at each division of the cell. Such rods are called chromosomes. Each species of animal and plant possesses a characteristic number of these chromosomes, which have a definite size and sometimes a specific shape, and have characteristic granules at different levels. The chromosomes are the bearers of hereditary units and many such units are carried by each chromosome. We might assume, by way of illustration, that the heart, liver, lungs, kidneys, etc., are all from one unit. Many such units are carried by each chromosome, for their number is limited, while the number of independently inherited characters is large. Thousands of cells make up the child's organism from the fertilized egg.

The egg divides into two cells, then each half divides again, then each quarter. This process continues until a large number of cells are formed, and out of these the child's organs mold themselves. Also, at each division of the cell, the chromosomes divide too, one half of them coming from the mother, one half from the father. Every cell contains the total of all the chromosomes, and as these latter are the bearers of the hereditary qualities, every cell in the body, whatever its function, has in consequence a common inheritance. In time comes a new process in the germ cells, a process essentially the same both in the egg and in the sperm cells. The chromosomes come together in pairs, each maternal chromosome mating with the paternal counterpart. There then ensue two divisions and the double chromosomes separate at one of these divisions, so that each resulting cell comes to contain some maternal and some paternal chromosomes, each pair, containing one of the other member. At the other division, each chromosome splits as seen in ordinary cell division. If this linkage were never broken, we should naturally expect to find that groups of characters would be inherited together. In fact, there would be as many such groups of characters as there are pairs of chromosomes. To a certain extent this is true, but the study of the inheritance of two or more characters in the same linkage group has shown that there takes place an interchange at times between the two members of the same linkage group, but never between different linkage groups. This is termed *crossing over.* To illustrate, suppose we take a female fly with white eyes and yellow wings and cross her with a red male with red eyes and gray wings; the males are found to be yellow with white eyes and the females are gray and have red eyes.[17]

The chromosomes are seen in the cell nucleus as pepper seed bodies. Within the last few years it has been established that their number is generally constant for a given species, but of course there are some exceptions. In man there are 24 pairs and of each pair one constituent has been derived from the ovum of the female, the other from the sperm cell of the male.[15] Now the genetic factors, the rudiments of the child's organism present in the chromosomes, some from the paternal, some from the maternal side, are constantly acting upon the cytoplasm (protoplasm) throughout the process of development. The egg's cytoplasm which has been formed under the dual influence of the maternal set of chromosomes appears to determine the very early stages of development in the child, so that if the sperm introduces factors which will act disastrously on the different stages their influence does not at first show itself. As development proceeds, of course, the influences of the paternal chromosomes come more and more into play, and further progress on the maternal side may be arrested.

An example is seen in the crossing of widely different species of fish. The early stages of cleavage run smoothly and follow the maternal type, but, as the embryo develops, irregularities and delays occur which bring progress to an end. As the egg divides, it produces a vast number of cells essentially like itself. Most of them become changed, as development proceeds, into the tissue and the organs of the body, but a few remain as reproductive cells of the individual in which they live. Here they multiply, to become, each in turn, the beginning of a new individual with its contained eggs. Thus the egg produces the body and not the body the egg.[17]

From the standpoint of the offspring both parents are important, for each contributes half of the heredity of the child, and the number of chromosomes is kept constant for the species.[18] Biologists know that male and female infants possibly differ in every cell of their bodies. Huxley, the biologist, says that male children have one less chromosome than do females. Biologically neither sex is superior nor inferior, but female children are, on the whole, stronger and healthier and live longer than do the males.

The germ cells, prior to maturation, do not differ in their biologic properties, in any important respect, from other cells. When they are about to pass through their final preparatory steps, they become much enlarged, as a result of nutrition absorbed from the surrounding cells. It is during or before this

growth period of the germ cells that their chromosomes unite, side by side, in pairs. These cells, as well as their sex chromosomes, may be totally unlike. However, the ones which combine in pairs represent the same things in heredity, in physiology, and in development; they are homologous, in fact. It may happen in cell division that all the maternal chromosomes go to one cell and all the paternal to another, the child resembling the mother or father in an amazing mass of characters and traits.

In most animals, notably in the human prototype, there exists a long interval between the maturation of cells, and the visible production of the inherited characters in the offspring. The infant or the embryo alike must undergo a long series of changes. Some of the inherited characters may appear very early in the child, but apparently very few do; the largest percentage usually show during the juvenile state or later in adulthood. The representatives of these traits, present in the fertilized egg, retain their capacity of producing the same sort of structures through all the embryonic changes or activities.[8]

COMPOSITION OF THE CHROMOSOMES

The chromosomes are composed largely of protein. They are exceedingly complex and relatively unstable. It is not improbable, says Shull, that their instability results occasionally in rather permanent modifications, continuing until another modification occurs. Since the processes of embryonic development are largely determined by the chemistry and the physics of the protoplasm, a change in their chemistry might easily modify the end results of development. Thus we are placed on guard as to the right nutrition. The modifications might affect only the physiologic processes, but they might even cause alterations in character.[8] From the evidence at hand, this much seems sure: that the paternal and maternal chromosomes respectively carry substances such as ferments, nutritive materials, etc. All are instrumental in giving the final purity of personal characters which are observed to be equally heritable from either line of ancestry.

It is clear, therefore, that most of the characters of an adult organism cannot be merely the outcome of any unitary substance of the germ. Each character is the product of many cooperating factors, and for the final outcome any one cooperant is probably just as important in its way as any other. Many natural species as well as cultivated varieties, even in plants, are in reality but

mixtures of subspecies or races, and upon being isolated these distinct forms reproduce their own particular type. This endless diversity among children or adults is even more marked.[13]

NUMBER OF CHROMOSOMES

Not only is the number of chromosomes constant, but they often have individual differences, so that one familiar with them can identify particular ones. In fact they might well but unpoetically be called Jennie, Mae, or Bessie. These chromosomes play a leading part in the internal control of the child's development; this evidence is overwhelming and incontrovertible. Such evidence falls into two great divisions; first, from the architecture of these bodies, secondly from the results of variation in the number of chromosomes in the total chromosomal complex of the species. Confirmation of the first evidence was gained when it was found that certain characteristics were linked in heredity. That means, that if two linked characters are found together in one parent and are not represented in the other, the linked pair will tend to recur together in successive generations of offspring. This can occur in both health and disease of the germ plasm.[14]

DAMAGED CHROMOSOMES

Many of these germinal variations show themselves in malformations of one kind or another and probably, to the laymen, the most vivid visualization of hereditarily damaged goods are these variants. The significance of organic dysfunction to him is usually the result of evil living; would-be normal characters gone wrong.[4]

Pediatricians have observed that in ill-balanced organisms certain organs show lessened function and development, and others in the same body show a heightened functioning power and development. Cardiodystrophy, giant growth, and diseases of certain organs follow, as Meggendorfer says, a common heritage or a combination of different hereditary conditions.[19]

The injurious effects of certain poisons upon the chromosomes, which tend to cause irregularities, variations, and malformations, and a subsequent abortive ripening of the developing embryo, which have been familiar to embryologists for a long time, have been already referred to. Often it would appear that the organs affected are the most delicate parts of the child's or-

ganism, requiring extremely delicate adjustments; for instance, the eye, the endocrines, the heart, and the liver.[17]

Those who have travelled extensively have observed the characteristic pigmentation of the skins of the various races. If this pigment is absent in both parents, it will of necessity be absent in the germ plasm of the child. The blondes of Sweden lack the necessary genes in their germ cells for the deeper grades of pigmentation, and their children have none. There may be an anatomical irregularity in the establishment of a character in the germ plasm. Remarkable though it seems, there are to be found communities where many children have an additional digit which is taken quite as a matter of course. Apparently this is due to an irregularity in the formation of fingers as the result of a peculiarity of the developmental process, which possibly follows from the pressure of a factor which gets in the way of the establishment of the five crenulations on the free margin of the embryonic flipper. These abnormalities are of a truly dominant nature and their dominance depends upon the presence of a disturber of development in the germ plasm. Again, in certain children, the bilateral elements of the palate fail to come together, so that a cleft remains between them. There is undoubtedly a genotypical basis of hare lip as well as of cleft palate, yet the carrier of its recessive may not show it at all. Syphilis and alcohol may be the agents for such damaged goods. A congenital droop of the eyelid, owing to an imperfect muscular control, is sometimes seen, and is represented in the germ plasm. Observers note that this may be a dominant trait passing to generation after generation without omission. Consider the extreme cases of amaurotic family idiocy in which the sensory nerves seem to fall behind early in development. In typically feeble-minded infants, the cerebrum lags behind in the development of the individual as a whole. The brain may be imperfectly formed, the bones likewise, so that they break easily in children, a condition tending to recur as a dominant for successive generations.[14]

DOMINANT AND RECESSIVE CHARACTERS

In the foregoing pages, the words *dominant* and *recessive* have been referred to in a general sense. By dominance in heredity is meant that one or more characteristics of one parent or of the other appear in the majority of the descendants and are often handed down from generation to generation in a pure form.

The word, recessive, on the contrary, is used when one or more characters appear in the minority of the descendants. Moreover these characters are known to lie dormant through one or more generations.

Mendel has shown that certain characters are inherited as a unit and are not divisible. Also, when these contrasting unit characters are present in both parents, the one becomes dominant, the other recessive in the offspring. Every single germ cell is pure as regards any given unit character. We are of the opinion, however, that while the Mendelian theory may fit in with the scheme of things in isolated cases, it seemingly fails in the inheritance of many normal human qualities.

The primary cause of a hereditary disease cannot arise in the parental body but only in the germ, and once the latter has been altered, the transmission of changes to subsequent generations takes place. Obviously we must ask ourselves how the germ undergoes this alteration and whether the process is related to the existence of disease in the parental body.

It may be that the pathologic changes in the parental organism injure the germinal cells in one way or another, but they never do it in such a way as to evoke in the germ the identical condition existing in the parent. Then again, it may be that the noxious influences affecting the parental body may not limit their action to that body, but may exert injurious effects upon the germ.[20]

CROSSING OVER

Perhaps chromosomes become mutinous at times, for occasionally their behavior fails to react along typical lines; a "crossing over" is a case in point. In fact, sometimes they break apart and exchange pieces with their homologous chromosomes, though not always. Also, when they do exchange their parts, the point of breakage differs in different cells. Another irregularity is the infrequent failure of the maternal and paternal members of a chromosome pair to go to different cells in the reduction division, a form of non-disjunction. Still another type of this non-disjunction is seen when halves into which the chromosomes divide, instead of passing to different cells, go to one cell.[8]

LINKAGE

Linkage insures that more than 25 percent of the offspring will exhibit the same combination of characters as was possessed

by one of the grandparents, and that more than 25 percent will be like the other grandparent. This is known as absolute linkage, and, fortunately for many children, is not common. Some children, however, take one character from one grandparent and another character from the other grandparent. This, as already stated, is called crossing over, and is a form of arrangement which establishes a new linkage.

How the exchange of the fragments of chromosomes is brought about is uncertain. In experiments upon the fly, Drosophila Melanogaster, many combinations of linkage were established. In man, with 24 pairs of chromosomes, many less are determined, so that, on the average, only one twenty-fourth of the child's inherited traits may form a single linkage group. Thus the chances of finding independent characters in our children are much greater than in the fruit fly already mentioned.

The striking resemblances of children to one parent in a number of ways may be due partly to linkage rather than to a more random recombination of hereditary factors.[8] If, then, the hereditary elements in the germ plasm are carried by the chromosomes, there should be as many groups of hereditary characters as there are kinds of chromosomes.[17]

This question of linkage is to many the most interesting, absorbing, and least understood feature of heredity. Morgan and his associates, in investigating linkage particularly in the Drosophila Melanogaster, or common fruit fly, found that occasionally this linkage was broken and that the crossing over occurred by which some of the offspring had only one of the usually linked pair and that the other offspring had all of the others. It was also found that the proportion of individuals showing this crossing over was variable for different distinguishable characteristics, or so-called traits. Morgan discovered 30 genes or factors to be located in one chromosome.

"Linkage is a general phenomenon observed not only in flies but in other insects, plants, and mammals as well. It is possible," to quote Davenport, "that the chromosomes are made up largely of packets of enzymes which are responsible for the development of those specific characters of the adult." In plants all kind of irregularities in cell division may take place and many peculiarities arise from all kinds of crossing over. The same cause is responsible for peculiar traits in humans. Unfortunately very little has been done in the case of man on the relationship between chromosomes and traits.

There are, of course, many types of linkage in man wholly unknown to us, but one linkage at least is known, that of *sex-*

chromosome-linkage. In many species of animals, for example, as well as in a few plants, it has been shown that one of the pairs of chromosomes is frequently peculiar in that the elements of the pair may be unlike in form and may behave in erratic fashion during cell division. This pair is known as the sex-chromosome. In the females of mammals and of flies the sex pair are alike in the female; unlike in the male. If we call the female chromosome X and that of the male Y, the female stands in the position of XX, the male in that of XY. The dominating features, the traits of heredity dependent on the X chromosome, are sex-linked. In our children, for example, such sex-linked characters may be seen as color blindness, hemophilia, optic nerve atrophy, etc. Sometimes in our male children one or more traits have come to be associated with the Y chromosome.

The existence of this linkage in human beings is well shown by a criss-cross inheritance, in that an affected father may have no affected children, and the descendants of his sons may never show this defect. However, half the sons and daughters of the original pair will show the defect and half of the daughters of the daughters will carry the defect, but will not show it, and it will appear again in their sons. It would seem, therefore, that in the inheritance of certain traits in our children as well as of those body qualities which permit alike the development of health and of disease, they are largely what the chromosomes have made them. We must not forget that a series of facts points conclusively to the vast importance of the ductless glands in determining the peculiarities of form, but the rudiments of these glands lie in the chromosomes.

Thus one cretin looks quite like another regardless of maternity, and the same holds true in the case of the idiot. Arthur Keith even believes that racial differences are due largely to these endocrine secretions. Whenever pediatricians speak of the important role of these endocrines in the growth and development of the child, they must not forget that these glands, basically and potentially, are bound up with the chromosomes from which they spring, and that they are developed under the control of these chromosomes; that their quality, size, structure, and functioning capabilities are due either to the high or low quality of these self-same chromosomes.[14]

SEX-LINKAGE

Some of the most peculiar disease characteristics seen in children spring from sex-linkage. The association of sex with certain

chromosomes and the presence in the same chromosome of genes for other characters leads to that heredity paradox.[8] Characters, too, whose determining factors are in the chromosomes that differentiate the two sexes cannot be expected to be inherited in the same way in both sexes.[8] Thus, beside physiologic or normal unsexed inherited characters, there are a large number of diseased characters which are sex-linked recessives located in the sex chromosome. Many such idiosyncrasies show themselves around the time of birth, some later, and particularly in male infants. In fact, we can expect in children about half of the transmitted characters sex-linked. In the other chromosomes, however, recessive characters may be compensated by similar ones, but not those in the sex-chromosomes of male individuals. Indeed, most of the diseased idiotypic variations are recessive in kind.

Many conditions which earlier physicians believed to have had scant affinity with inheritance are now assuming greater importance in medicine. Many biologists, Lenz in particular, feel sure that lethal characters which are located in other chromosomes are not sex-linked, but in some way seem to have an uncanny influence over such pathological states as abortion and miscarriage, which fall in the field of gynecology, and should be considered quite apart from diseased characters brought about, for example, through syphilis, gonorrhea, endometritis, lead poisoning, infantilism of the uterus.[21] In further illustrating such sex-linked disease characters, consider one well-established disease rarely seen in children, color-blindness; the inability to distinguish different shades of red, or red from green, or, in other words, a red-green, a disability more common in men than in women. The child can be color-blind when only the maternal side of its ancestry is affected, and the existence of this defect on the paternal side has no effect. In brief, a color-blind woman must have a color-blind father and mother, or at least, be pure for the color-blind factor.[8]

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CHAPTER 2

PHENOMENA OF MATING

TRANSMISSION OF CHARACTERS

THE MORE thoroughly we investigate natural phenomena the more complex we find them to be. Nature is always greater than our theories and, with few exceptions, hypotheses which seem to be more or less accurate at an early stage of our investigations have to be extended, modified, or abandoned as our knowledge increases. While the application of Mendel's simple principles to the many phenomena of inheritance is, in the main, reasonable, yet it is necessary to enlarge upon these principles or to modify them in many ways. So exact and painstaking were Mendel's methods, however, that the fundamental truth of his principles has been established in a large number of cases, and, what is more, has been extended to forms of inheritance to which at first they apparently could not be made to apply. At present there exist no workable theories but those of this great monk. In physiology and in pathology we recognize the transmission of unit characters. Such characters cannot be independent and discrete.

The child's organism itself is a unity and so is each and every one of its parts. Every character must influence more or less every other character and every part of the organism if we are to believe the axiom of the physiologist that "no part of the body is absolutely independent of other parts." Certainly unit characters cannot be absolutely independent of one another; the various parts and organs of the child's body are all dependently correlated.

Nevertheless, one should recognize varying degrees of independence, since organs, cells, and parts of cells are hereditary units and characters. For that matter, every character is complex, for many factors enter into its development, and since the combination of these factors is variable, the character itself cannot in the nature of things be constant. Different combinations of units give rise to different adult characters.[1]

As long as the hereditary-factor pairs are identical, the one maternal, the other paternal, in the fertilized egg, the course of development runs smoothly. Dominant characters are trans-

mitted to the child for good or bad. However, if one member of the pair acts in a different manner from the other, sooner or later some character, some organ, for instance, may deviate owing to a conflict of factors, one becoming dominant, the other recessive.[2] Traits common to both father and mother, owing to summation, may attain marked development in the child. Sometimes certain characteristics seem to rise spontaneously in children when, in reality, the parents possessed them to a moderate extent.

A mingling of characters may lead to the appearance of some quality which was not existent in the ancestry as such. Idiosyncrasies of metabolism, certain skin eruptions, eccentricities of one sort or another, might be cited to bear out these facts. Sometimes parents find complicating features of inheritance, sometimes duplicate factors, and sometimes compound factors in their children.[3]

Again, inheritance characters may be blended. For instance, when long-eared rabbits are mated with short-eared ones their offspring have ears of intermediate length. The average height of children of very tall or of very short fathers tends toward the normal average height. This is called *regression*. It does not mean that all children of short fathers will be taller than their fathers, for some will be taller, some shorter, and some the same height. Generally speaking, however, the average height of the children will be greater. Galton in his investigations concluded that, on the average, parents contribute half of the heritage of an individual, grandparents, one-fourth, great-grandparents, one eighth, and great-great-grandparents, one tenth.[4]

Some of the individual units in the germ plasm are passed on to the child from the father and mother and their recombination determines how far the individual resembles his parents. There may be characters in the child which are not visible in either parent, so-called hidden or recessive unit factors. For such a recessive character to become manifest in the child, it is necessary for both parents to carry it latent in their germ cells. Being in that instance a double-strength character it becomes dominant in the child. On the other hand, it is possible for a unit factor to become manifest in the offspring, although received from only one parent. When this factor tends to dominate over a similar unit factor in the other parent, it becomes a dominant unit factor. Many children seen by pediatricians have at least one such character from both parents. When we translate these facts into terms of disease characters we can perhaps more readily understand how diseased organs and pathologic potentialities

may come about. Sometimes unit factors, particularly some of those which determine certain diseases, are coupled with other unit factors which determine whether the offspring shall be male or female. In such a case, for instance, a disease may appear only in male members of a certain family even though it is transmitted by the females, a fact not evident because the unit factor or the factors upon which the disease depends are recessive. This type of disease would be called a sex-linked form of heredity.[5]

Among our children we see genotypical characters transmitted from antecedents. As an illustration, in individuals of the same species some are found with coarse hair, some with fine, some with curly, and some with straight hair. Also one finds children with high narrow noses, others with flat noses, some with long heads, and others with round ones. Many of the racial stocks are genotypical, often dominant and uncontrollable from generation to generation. With the hybridization of two stocks or races, one dominates over the other, retaining at the same time developmental differences. The white race develops differently from the yellow or from the black. In European races are found all types of developmental differences in totally different strains. Note, for example, the short-legged Mediterraneans and long-legged Scots, the heavily pigmented Italians and the slightly pigmented Scandinavians. A condition normal for one race is abnormal for another, depending upon the internal or hereditary factors.

Even in the same family one may observe different dominant qualities. Amid the same environmental surroundings, but with diverse internal developmental conditions, the children may differ in body build; some may have blue eyes, some brown, grey, or black, in addition to many other diversified characteristics. All these differences in developmental reactions are found to be present in the germ cells of the parents, who are probably hybrids like their children.[6]

The modifying factors in the transmission of character play an important role in that they produce small differences in the inherited character. It is usually hard to know or to demonstrate whether these slight differences are due to genetic modifying factors or to environment. If they are due to environment they are not inherited, but many genetic modifying factors affect particular parts, making them more or less intensified than is exhibited in the average individual. Each gene or hereditary factor in the chromosomes affects not only one part of the organism of the child but other parts also, in structural alteration and in physiologic effects. Some of these hereditary factors are im-

portant in their influence on the physiologic functions of the body and produce side effects which show themselves in apparently trifling details of the body structure.[7] There may be a dysfunction in the physiologic arrangement of a transmitted character, as seen, for instance, in the inheritance of albinism, showing a lack of the enzyme that produces brown pigment.[6]

MODIFICATIONS, VARIATIONS, MUTATIONS

No one can imagine descent from parents and from ancestors without modifications in the inherited characters. If this were not the case, individuals would have no characteristics differing from those of their parents. Each child would be like its parents as to body build, size, structure, and function of all its organs and tissues, and each new generation would have to start back at the very beginning of the life cycle. Individuality is common to all organism, plant and animal. There are no two trees precisely alike, no two leaves, no two flowers, no two animals, nor are there any absolutely identical infants or children. Therefore no two children can be raised alike, no two nourished alike, for no two have the same metabolic rate, no two can be treated alike medically, although suffering from the same malady, no two can be disciplined alike, and no two have identical emotional states nor the same kind of balance between the brain and the other organs.

In previous years variation has often been regarded by scientists as opposed to heredity. It is, however, universal among all forms of organisms. Darwin regarded simple individual variations, those arising in certain individuals of one parentage, as due to chance and subject to the conditions of natural selection.[8] Weismann contended that variations are germinal in character, that they first appear in the egg and in the sperm as changes which later bring about modifications in the individual. This means that the offspring of a pair of animals are not affected by the structure nor by the activities of their parents, but that the germ material is the unmodified stream from which both the parent and the young have arisen, hence their often marked resemblance.[2]

In the minor details of color and shape, in which individuals differ among themselves, says Shull, the influence of the ancestors is seen in a high degree of invariability.[3] Some of these variants may appear even after two generations. When, in the fertilized egg, the author adds, these mutants remain mostly unimpaired through all the hundreds of cell divisions, it is hardly

to be expected that a complicated mechanism like the living body will function with absolute accuracy. None of us are one hundred per cent perfect in brain, or body, or both.

False steps do occur in physiologic processes and in embryonic development. In such cases the child at birth may present a curious patchwork of inherited characters.[3]

There is an endless diversity of variants or mutations among individuals, differences between members of the same family and of the same generation, as well as between parents and offspring. These character differences, then, either represent something specific in the germ plasm or they are merely the effect of external stimulation upon the body cells. In the first case, says Newman, they are inherited, although they will not necessarily reappear in all later generations or in all progeny, unless the same conditions exist that caused the original variations. In the second case, they are not inherited. Such mutations, although heritable differences between parents and offspring, do not depend on segregation and recombination to effect their results. Modifications comprise a large portion of what are commonly spoken of as fluctuations, due, however, to environmental stimuli. Variations may be divided into three general classes:—(1) physiologic, including bone hardness, flavor of meat, richness of milk, etc.; (2) psychologic, or differences in mental traits and in nervous conditions, which reflexly show distinct effects upon the physical conditions; (3) ecologic, the differences between individuals in their relation to environment.[8]

We realize, then, that there may be in the child recombination of already existing characters. Parents often see characters for good or evil in their children similar to those which they themselves possess and for the possession of which these children are rewarded or punished. Moreover, there may be the introduction of new factors, new characters, also for good or evil, through changes in the constitution of the chromosomes, characters which they as parents do not possess. While the whole cell system of an animal or plant is involved in the production of any character, yet the way in which the characters are interrelated and the developmental processes are arranged so as to ensure their appearance at the right time and in the correct position of the body, is a mystery.[4]

Modifications are more easily produced and are probably more profound during cell division than during the intervening periods, and at the early stage of development rather than at a later one. Conditions which have no serious effect on an adult organism may greatly modify the development of a germ cell

or an embryo. Many investigators have discovered that development in the child may be profoundly changed by influences acting upon the germ cells of its parents before fertilization, during the growth of the female ova or of the male spermatozoa. In general, it may be said that environmental changes acting during the growth of the ova or of the spermatozoa, especially during their maturation, may produce marked changes in development, though rarely if ever in heredity.

In his experiments with the potato beetle, Tower has found that unusual conditions of temperature and humidity during the later stages of oogenesis and spermatogenesis may even lead to the production of new races. MacDougall's experiments on plants point to the conclusion that chemical substances may influence the ovules to such a degree that the hereditary character of the plant is changed.[1] It seems to be conclusive that certain conditions within the parent's body may so influence the germ plasm that beneficent or faulty developments may result in the child.

Indeed, that the germ plasm could in reality be reached through the body itself, was proven by Sitowski in 1905. He fed the larvae of a certain species of moth the fat-soluble dye of sudan-red. The coloring effects were visible in the adults, in the eggs, and in the larvae of the next generation. This, of course, is not a true inheritance. In 1914, Cole and Bachhuter carried out an ingenious experiment in which they mated to a female rabbit both a normal male and one that had been fed lead acetate. The retarded development of the progeny from the second male suggested a definite effect of the lead acetate upon the germ cells.[9] As great an authority as Morgan says in part, "It is conceivable that the germ cells may be affected by the vicissitudes of the body cells, so that when their turn comes to produce a new individual they reflect in some way the changes that have been expressed upon the body cells, the organism." "Also," adds this author, "there is a possibility that the changes of the external world which affect the body may produce a corresponding change in the germ cells." [2] The germ cells might be influenced for good, for example, through regular muscular exercise of the person, which might in some way cause some general change in the juices and secretions of the body, and these altered juices, the hormones, reaching the germ cells, might exert an influence upon them. The germ cell would not, of course, reproduce this effect.[9]

Many scientists consider that temperature changes may affect the germinal cell. When cold affects the germ cell, says Ribbert,

the skin rudiment of that cell will be altered in the same way as the skin of a human is altered. Changes in the germ cell, he believes, may be said to arise in two ways:—first, a change-inducing influence such as alcohol or the x-ray may invade the parental body and influence directly the germ plasm; second, the environmental influences induce some modification in the body, a change perhaps in some vital process, and this may affect some particular part of the parental body, giving rise, in time, to the acquirement of new characters. At the same time environment may influence the germ by inducing a corresponding change in the rudiment of the same organ affected in the parent, a **Parallel Induction.**[10]

It is often exceedingly difficult to interpret those character changes, these mutations in the child, as springing from a mutation rather than from a recessive character, perhaps dormant for many generations and finding a suitable recombination to make its appearance. Some of these recessives may go so far back in ancestry as to be atavistic. True, the gene, the hereditary factor, is regarded as a chemico-physical product, and mutation a change in characterization. Therefore it is quite possible that these mutations may be produced through physico-chemical agencies, environmental substances working directly, presumably, but possibly indirectly as well, upon the germ plasm.[11] With these minute chemical changes taking place within the chromosomes, just what determines human characters is unknown. Some biologists of to-day are convinced that they are determined by the cytoplasm of the cell, and that this cytoplasm, or the protoplasm situated outside of the nucleus, assumes a great variation in cytoplasmic inheritance.[3] In fact, says Morgan, it has been found that a variation in a transmitted character arises in the germ material no matter what its cause, and may affect any stage in the development of the next individuals which arise from it. There is no reason to suppose, he says, that such a change produces a new character which always sticks itself on to the old order of things. In recent years it has been discovered that sudden changes do appear at times in the germinal elements, changes which affect one or even more characters of the organism. These mutants, so-called, breed true to new type.

In many groups of animals and plants new kinds of individuals are seen to appear suddenly. The new characters which they show are transmitted to their descendants. In some cases these new characters depart widely from those of the stock from which they spring; in other cases these changes may be slight and pass unnoticed unless one is familiar with the parent stock.[2] Abel

says that the inheritance of mutations is indispensable for evolution of the species. Birds of North America, he cites, when flying from the north and east toward the south, gradually become of lighter color and grow smaller in size. As scientists are so uncertain of the causes of these variations in transmitted characters, there is of necessity a great deal of controversy concerning them.[12] This controversy is found notably among two groups, the Neo-Lamarckians and the Neo-Darwinians. The former believe that the offspring inherit the characters which have been acquired by the parent or parents through changes in their environment.[13] The latter hold to natural selection as the cause, and have no belief in the inheritance of acquired characters.[12] While mutations are solely hereditary in character, there are thousands of fluctuations in the body cells which do not affect the germ cells at all. As a result of the permutations of ancestral characters, the appearance of mutations and the fluctuations in the body organs of the child are due to environmental changes. Thus, no two children are absolutely alike, even though they be twins.[1]

The causation of the variation of species is by no means an easy problem to solve. Darwin was the pioneer in giving the matter serious study. Many modern biologists have advanced the belief that variations are not due to chance simply, nor to the laws of environment, but are the consequence of some little-understood vibration of great penetrating power which comes to us out of the earth or out of the abyss of surrounding space. At least, such a belief has been expressed by Dr. F. K. Richmyer, Professor of Physics at Cornell University. Dr. Richmyer has described his researches in the production of new plants and insects by exposing seeds and eggs to the x-rays. It has been supposed, especially at earlier periods, that this variation in species resulted fundamentally by slow degrees from environmental changes. Biologists, however, have recently exposed the eggs of the Drosophila, or fruit fly, to the x-rays, and almost immediately extreme biologic changes were observed. Dr. Richmyer conjectures that if rays of the speed and penetrating power of the x-rays can produce such remarkable fluctuations, rays of a much greater penetrating power, such as those discovered by Dr. Robert A. Millikan, the cosmic rays coming to the earth constantly from outer space, may exert an even greater effect.[8]

The question of the cause of mutations has been a thorn in the flesh of biologists for years. The formation of such variants is of special interest to breeders of animals, race horses in particular, as well as to students of genetics and eugenics.

Herman J. Muller, of the University of Texas and Frank B. Hansen, of Washington University, St. Louis, have been for some time experimenting with animals and plants, and have been able to bring about many new and undreamed of mutations, especially with the aid of the x-ray. The production of these variations in the low forms of animal life would seem to warrant the conclusion that some day somewhat similar results, but on a higher plane, may be expected among higher animal forms, the human race. These men also experimented with the effects of x-rays upon the hereditary factors, or genes, of the fruit fly and found that large numbers of mutations could be effected. It would seem conclusive, in the theory of Dr. Muller, that the x-rays really do affect the chromosomes, possibly dislodging them into new arrangements.[14]

A considerable number of variations in our children are morphologic, functional, or regulatory; yet all are compatible with health, even though each variation may entail some special individualistic predisposition to disease, since the variation may limit the powers of adaptation to the environment. Extreme conditions in connection with these states, however, extend beyond the scope of the pediatrician, and fall into the hands of the surgeon or come within the specialties of other physicians.

Morphologic *Personal Variants* are seen as differences in habitus. The functional "personal variants" are seen as biochemical composition or differences in modes of reaction. Evolutive and involutive "personal variants" appear as differences in the time of reaching the developmental acme, often in the phenomena known as *senescence.* All these are of interest in the study and search for clues in disposition, in disease, and as a guide in the prevention of illness.[15]

Indeed, matters become very interesting from the pediatrician's standpoint when external stimuli change the material basis of heredity and alter the inheritance pattern or idiotype. In the offspring of that person, says Siemens, who harbors the altered inherited substance, there will appear new characters which, like all other characters originating in the inheritance material, are transmittable. Such idiokinetic influences are, in general, entirely unknown to us, he affirms. The same author adds that in man nothing is known for certain with regard to such influences, but in unicellular animals and in insects such idiokinetic conditions can be produced experimentally by heat and cold, as well as by poisons such as alcohol, by syphilis, and by the x-ray.[14]

TRAITS

Personal peculiarities then, have a constitutional foundation. It is supposed that when two or more spermatozoa enter the egg of the female in impregnation the nuclear divisions are usually abnormal and the distribution of chromosomes to different cleavage cells is unequal. Such cells do not undergo typical development and the embryo produced is not capable of continued life. In such cases, where an egg is fertilized by a spermatozoon belonging to a different class, the foreign sperm, after stimulating the egg to begin development, may itself die or remain inactive and the hereditary traits developed naturally spring from the mother. In other cases environmental changes acting upon the oosperm after fertilization or upon the embryo may produce an almost infinite variety of abnormal types of development, none of which, probably, are hereditary.[1]

Certain breeds of dogs, such as the mastiff, bulldog, terrier, and collie, are characterized by peculiarities in temperament, much as are children. Affection, intelligence, and disposition are of different ratios and degrees in all of them. The human race and individual families have much the same characteristics and in just about the same proportion.

From observation it would seem that pediatricians as a class concern themselves but little with the hereditary dominants and recessives in ancestral diseases. Others may limit their considerations to the abnormalities and pathologic conditions of one or two generations.

Without more or less complete records, it is almost impossible to get a fair or accurate knowledge of the history of hereditary disorders, ancestral traits, matings, and germ plasm abnormalities in the offspring, for too many such secrets, if known, are looked upon as family skeletons and are therefore carefully guarded. Pediatricians are often forced to accept only that which they observe in the child, and usually must trust to luck that the personal questions, often skillfully sidetracked by the parents or relatives, are somewhat truthfully answered.[6]

There are so many mixtures of these physiologic and pathologic peculiarities that, at present at least, no thorough classification is either probable or possible. Davenport and others have tabulated over sixty pathologic traits alone, believed to be Mendelian in character, some being dominant, some recessive, and others sex-linked.[15] If human normal traits are dependent on the proper environment, it can be postulated that child after

child placed in an unfavorable environment will develop an abnormal organism and pathological traits. That means, however, that through a continued unbalance of his body as a whole when certain organs alone function improperly, many mental or physical traits may become latent, as other organs assume the responsibility of developing other active traits.

Other interesting manifestations called *instincts,* found so universally in the lower animals and insects, are undeniably bound up with transmitted characters. Examples of these are the breaking of the shell by the unhatched chick and the spinning of the cocoon by the caterpillar.[12]

Sometimes a character has a continuous variation, one modification overlapping the next. New forms arise from the recombination of these Mendelian factors. As many factors are concerned in the production of any living thing, a child's organism, for instance, has an incalculable number of these *recombinations.* There may be changes either in the number of chromosomes or in some parts of the individual chromosomes, caused by some accidental rearrangement in cell division, which results eventually in the weakening or strengthening of some part of the child's organism, evolving new possibilities of subsequent recombination. Several factors when acting alone give similar results, but when acting together increase the effect. Multiple factors are seen in human stature, in the disposition of bone or cartilage, etc. A change in a hereditary factor or determinator, so-called, however slight, may react subsequently upon the whole body, and may be a cause of death in the infant or child owing to a mal-development of an important organ, affecting, in turn, a number of other organs dependent upon its copartnership. A mutation, some poisoning of a chromosome or of a factor controlling the ductless glands of the child's body, might produce changes of the utmost significance; for example, overdevelopment of the thyroid gland, or underdevelopment, or at least a dysfunction of that gland, may be manifested, for instance, in abnormal stature. Similar conditions may be observed in other organs.

Thus, these variations creating new characters in the mating organism may be of two kinds, a recombination of existing factors or the introduction of new factors.[4] Every higher organism is, as a matter of fact, a multi-split hybrid; therefore, we may see traits in our children which we do not possess. In fact, the transmission power of an individual is quite different from his value as progenitor. It is one thing to describe the

individual as to his size, form, color, and impulses, but quite another to construct a pattern of his transmissible factors.[14]

Many pediatricians do not interest themselves in biophysiologic evolution in its relation to mutations; to them pathologic mutations are of much more value. In the case of children, most mutations, while producing almost imperceptible effects, are, nevertheless, very common. If they are purely physiologic or moderately pathologic, they arouse no special attention, for they are merely passing phases of mild dysfunctions whose correction requires no special skill. "For," says Huxley, "mutations which produce large effects not unnaturally often throw the complicated machinery of life out of gear, while those whose effects are smaller, the common ones, are often neutral or beneficial." Undoubtedly *natural selection* is the most important agency in sifting out these small mutations. Under normal, natural conditions, mutations are rare, perhaps one in every 10,000 children. This ordinarily small crop which we find under natural conditions may be produced by the so-called cosmic ray. It is known that animals taken down into deep mines where fewer cosmic rays penetrate appear to have fewer mutations than usual, while those bred at the tops of mountains where the radiations are more intense seem to show more mutations.

It is well to realize that both physiologic and moderate pathologic variants are of but passing interest to the busy pediatrician, in marked contrast to those unhappily severe forms seen in constitutional disease.[16] One must logically believe that the health or disease of the body reacts favorably or unfavorably on the germ plasm. Many physical or psychic stimuli acting on the organism are known, many unknown. Among the latter there may be the cosmic rays emanating from territorial space, indeed from an electro-magnetic field, and whose stream of electrons charges down toward the earth from the sun to filter through its crust, there to generate electrical currents. Is it not possible that those rays so affect the body, and thus the germ plasm, as to produce mild or even severe mutations?

Finally, in the light of the present knowledge of heredity through experimentation, we may be compelled to amend some of our ideas. It is possible that many of the supposedly inherited defects in organs may be the results of a malposition of the uterus, faulty nutrition of the mother, errors in prenatal development, changes in temperature, in food, and, in fact, in the physiologic and psychologic environment of the mother. In experiments with the eggs of birds and fishes, it was found that living matter was extremely susceptible to the rate of velocity

in development. Anything, Professor Dunn found, which changes the development of the fertilized egg, such as heat or cold, may produce abnormalities. However, we are dealing only with theories, and man with all his science cannot change the purpose of life.

HYBRIDIZATION

Pediatricians often find it advisable to inquire into the ancestry of their patients. In a few instances they may encounter inbreeding. Very often, too, they will find cross-breeding or hybridization, since practically all of us are hybrids. We may be what are termed "pure hybrids" from the crossing of different strains of the same race or stock, or we may be "impure hybrids," individuals resulting from the crossings of unlike strains and races. It has long been known that in the crossing of different but strong races, or even species of animals, the result, in the main, is the production of a first generation of hybrids characterized by a greater sturdiness, vitality, and size than either parent species.

Various phases of hybridization may conform to Mendelian heredity, others, however, have only a more or less remote connection with this conception. Evolution has certainly taken gigantic strides in this process of crossing over, for it is at least a contributing factor to racial vitality and usually to personal vigor. Undoubtedly hybridization has resulted in increased power of body and mind, particularly if the two strains are of a similar sound character.

It is known to agriculturists that in regions where the growing period of plants is short, cross-breeding results in an earlier harvest than when pure-bred strains are used. The hybrids produced by crossing the eggs of the fish, Fundulus heteroclitus, with the sperm of Fundulus majalis were found to be more viable, faster growing, and more vigorous than the pure-bred young of either species. On the other hand, the hybrids from the reciprocal cross showed a much reduced vitality.

The layman can often recognize in the child the features or some other outstanding characteristic of both parents. Dominant variations are more favorable to the development of the child than are the recessive. Pediatricians working among children of sound cross strains cannot fail to notice that this crossing usually brings out the qualities which are favorable to growth, but which suppress the abnormal and unfavorable characters of their parents. In our large cities, however, the clinician

often observes crossing so diverse that the union of different strains in mother and father is incompatible with normal growth in the children. Indeed, if the parents are themselves hybrids, further crossing may bring together recessive characters of weakness and disease, rather than dominant characters favorable to normal growth and health. There is also the possibility of the transmission of abnormal characters. When this occurs, further crossing, if continued, will tend to weaken the descendants.

Hybridization may be very disastrous unless accompanied by rigid selection and the elimination of inferior strains, and the clinician may have a difficult task in treating the children of such unions. Thus the beneficial effects of good crossing is nothing more than the workings of the laws of heredity. In various countries the writer has had the opportunity of studying the best as well as the worst results of hybridization. The economic situation of the parents is a factor for consideration. If nutrition and its environmental factors are adequate even the mating of two divergent strains may tend to improve growth and organic function and increase mental and physical vigor, especially in the first generation. Reverse conditions may bring about opposite results, particularly in the succeeding generations, when further crossings may uncover recessive characters of weakness, malfunction, and physical and mental inferiority. If hybridization could be held in check after one generation, nothing but good might come of it, but in man with his passions and emotions often unrestrained, and often with false conceptions of love, cross-breeding is more or less indiscriminate, and recessive characters may result in the outcropping of all sorts of physical and mental weaknesses.

Among the intelligent classes of all countries a more or less rigid selection is adopted. Under such circumstances, and with the elimination from parentage of the less desirable combinations, many racial stocks all over the world have flourished. In nature, as against the human average selection, foreordained natural selection is of a much higher quality, for it seems to eliminate the worst from continuous cross-breeding. It would appear, however, judging from the riff-raff found in the large pediatric clinics of the world's important cities, that little has been done to prevent the worst in racial admixtures from predominating.[8] The offspring of such mal-matings tend to increase infant and child mortality rates and add to the woes of the physician in his striving after improved nutrition and better medication.

INBREEDING

Much of that which has been said of cross-breeding may well apply to inbreeding. In the latter case, however, the results may be more disastrous. Pediatricians in the larger cities often find evidences of inbreeding which are sometimes local, sometimes racial. Victims of pogroms and various other forms of persecution and those suffering from economic distress make up these groups. The establishment of a home community in a foreign land amid alien languages and customs fosters closer family unions with consequent inbreeding. Such a picture may be seen to-day in Galicia, Poland, Russia, and Hungary. There is, however, a wide-spread and deep-seated feeling, particularly among the laity, that the mating of close relatives is unnatural and harmful. In most modernized countries there are both religious and civil laws forbidding such measures. Most authorities feel that the custom of some families and of some races to inbreed more or less has its unfortunate aftermath in loss of vigor, in faulty reproduction, in moral weakness, if not in actual crime, in organic malfunction, and in the early decay of the organism, or in the enfeeblement of the child, if it survives.[8]

It must be admitted that the crossing of two races by the mating of individuals who are slightly inbred produces, in humans and in animals, an enhanced vigor which shows itself in increased fertility. A generation of closely related parents with lowered fertility, however, produces individuals with lowered fertility, for the vigor of a child depends upon the mean of vigor between the parents; and this vigor continues throughout life, although strongly affected by environment.

Some outstanding figures in history were the result of intensive inbreeding. Among them were Peter the Great of Russia, King Ferdinand, Queen Isabella, and Charles V of Spain, Frederick the Great of Prussia, Gustavus Adolphus, and Charles XII of Sweden. In truth, the concentration of ability due to fortunate royal matings decided their characters, yet their transmitted genius was dissipated later through unwise unions. History tells us that almost without exception the descendants of these individuals were epileptic, mediocre, imbecile, feeble-minded, immoral, cruel, or depraved,—all recessive characters transmitted to the males in line, while the females escaped.

With the exception of the past two generations, Spain's ruling families have intermated for some 4000 years. Charles Darwin himself married his cousin, Emma Wedgewood. They had, it

will be remembered, four healthy and illustrious sons. On the other hand, intermarriage has wrecked some of the royal families of Austria, and, at present, is bearing down hard on that of Spain. The Eskimos of North Greenland, living within an area of 250 square miles, have intermated for years, yet they seem to bear no structural or mental defects.[17] Poech reports a Papuan tribe in complete isolation which, after long years of inbreeding, has suffered no evil consequences.[10] Consequently, in our clinical observation and our studies of infant mortality and the causes of youthful invalidism or mental and physical inferiority, we must, in all justice, give the matter deep consideration.

Among the enlightened of our modern world, selection has rid many of nearly all of their unfortunate recessive characters. Rosanoff and Orr, in a study of 206 matings between individuals from more or less the same stock, found that of 1,097 children, 586 were normal, while 351 were afflicted and 146 died in childhood.

History recalls that in the distant past close inbreeding was sanctioned both by the clergy and by law. At this period also inbreeding existed apparently without bad results. Brother mated with sister, uncle with niece. Among the royal families of Egypt and ancient Peru, it was common practice for brother to mate with sister.[8] The Ptolemys who ruled over Egypt were responsible for its brilliant and polished civilization for many generations, in spite of inbreeding. From this healthy and vigorous stock came several members all of whom were inbred but who gave an added impress of high intelligence and character. Cleopatra herself was a member of this group.

SELECTION

Selection may be either artificial or natural. In artificial selection among humans, which by the way is nothing but purposeful inbreeding of individuals characterized by similar dominant qualities, the splendid dreams of fond relatives may be shattered. The paratypic and desirable characteristics may in time disappear and less desirable recessive qualities of heredity take their places. However, natural selection has proven of great benefit to civilization on the whole, and it stands to reason that the children of such a union, although not, perhaps, inheriting the fullest quality of their parents' advantages, yet stand on a potentially higher plane than children less favored.[14]

ANALOGIES IN PLANT LIFE

In our study of variation in inherited characters, a brief glance at heredity as manifested in plant life should prove of interest. While cross-breeding, or hybridization, had been long known to biologists, it was the exact and detailed records kept by Mendel which enabled students to know that variations in hybrid progeny followed definite laws.

An illustration of Mendel's Laws is seen when plants which belong to the same species but which breed true to different colors are crossed. The offspring, or *first hybrid generation,* resulting from the mating of red-flowered and white-flowered plants, produces plants bearing only red flowers. When this first hybrid generation of all red-flowered plants is allowed to interbreed, their offspring, constituting the *second hybrid generation,* results in 25 per cent which resemble the dominant grandparent (red), 25 per cent which resemble the other, or recessive, grandparent (white), and 50 per cent which are like their parents and, at the same time, like their dominant grandparent (red). This gives a ratio of dominant to recessive characters of three to one. The next breeding constitutes the *third hybrid generation.* Of these, the white, or recessives, breed true (white); however, of the red, or dominants, one third breed "pure," (red); and the remaining two thirds, "hybrid." Thus, according to Mendel's First Law, the types of individuals obtained from cross breeding are:—

(1) Dominants which breed true.
(2) Dominants having offspring which are both dominant and recessive in the ratio of three to one.
(3) Recessives which breed true.

In other words, a gamete, or germ cell, carries only one of any alternative pair of characters, so that, the red character being dominant, the resulting offspring are red in color even though they contain mixed color factors. In succeeding generations, these factors *segregate,* a statement known as Mendel's Second Law, thereby permitting a subsequent recombination according to his First Law. Does it not seem probable, then, that when the human organism results from a combination of healthy and pathologic factors the latter may be dominant? [18]

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CHAPTER 3

THE BIOLOGIC CELL

STRUCTURE

In a study of child nutrition it is well to consider the fundamental principles underlying growth, function, and repair in the child's organism; to study the anatomical and physiologic structure, the functions, and the nutrition of the biologic cell. Nature in her systematic organization fashions different kinds of cells to meet the requirements of the various organs and tissues with which she has to deal. Basically, however, all cells are of the same mold, differing only in their conformity; their activities being common to all.

The basis of the cell is *protoplasm*. Protoplasm is the basis of all life, and all life processes are accompanied by chemical changes, or metabolism. Each cell incloses within its walls a spherical *nucleus* which is surrounded by the cytoplasm. Both nucleus and cytoplasm consist of protoplasm in different forms. In the nucleus are embodied the various products of differentiation, such as muscle and nerve fibrils, secretion products, and food substances.[1]

The cytoplasm, or cell-body, is a semi-fluid, jelly-like material, varying in the details of its appearance in the cells of different tissues. The mature cells contain granular material which consists of fat, protein, glycogen, ferments, pigments, etc. The chemical composition of the cell is, more particularly, made up of water, carbohydrates (glycogen, dextrose, etc.), proteins, particularly the nucleo-proteins, fat globules, lipoids such as lecithin and cholesterol, inorganic salts (especially potassium, sodium, calcium, calcium chloride, and phosphates), ferments, and pigments. This recital appears almost as a guide book to show the rudiments of nutritional factors so necessary in our foodstuffs.[2]

The nucleus and cytoplasm contain particularly more or less water and inorganic salts. Protoplasm, then, is a complex chemical combination of oxygen, hydrogen, nitrogen, and carbon, a fact to be remembered in the discussion of metabolism and of food.

Protoplasm is so complex that complete understanding of its composition is not possible, but it does contain various sub-

stances in various states of combination, associated by forces of surface tension, electrical charge, etc. Its liquid state permits an elaborate play of forces. Undoubtedly chemical reactions can proceed simultaneously in different parts of the cell, and there is a mechanism by which one part is undoubtedly isolated from another, at least temporarily.[3] The activities of this living matter are regulated by a heterogeneous system of colloids, crystalloids, and solvents. It is at once the most enduring and the most easily destroyed of substances; its molecules are constantly breaking down to furnish power for its vital phenomena, yet it is at the same time building up its composition anew from the surrounding medium, and usually in excess of that lost by disintegration. Each cast-off cell is possessed of qualities identical with those of the parent mass. Upon the attainment of a certain size, most or the whole of the constantly accumulated excess is freed from the parent organism in the form of germinal particles, each of which continues the process of assimilation and goes on in the ordinary way, getting the same nourishment, etc., as does the parent cell.

The cell is constantly attempting to convert all available material into living substance, and to multiply its own prototypes. The nucleus controls all the vital functions of the child and is remarkably complex in nature. Any thrown-off fragment of a cell, if provided with a nucleus, will, with its fellows, restore a part destroyed or mutilated in cell repair.[4] The study of protoplasm has its drawbacks, for while we can watch the movements both of and in living protoplasm under the microscope, we cannot stain it nor can we examine it chemically without killing it, and probably without fundamentally altering its characters. There is reason to believe, too, that the living matter in one part of a cell may differ from that in another part while the cell is alive, so that different parts of a cell may draw from the blood stream quite different food principles.

Wallace defines protoplasm as a substance so complex chemically as to defy exact analysis, it being an elaborate structure of atoms built up into a molecule in which each atom must occupy its true place like every carved stone in a Gothic Cathedral. Pfluegar tells us that living proteid or protoplasm is a huge molecule undergoing constant formation and decomposition, behaving toward the usual chemical molecules as the sun behaves to small meteors. The nucleus appears to be the most important part of the cell, and the chromosomes are essential factors in heredity.

The cytoplasm acts as a stimulant to the nuclear protoplasm

and may indirectly regulate the process of cleavage. "We may safely consider," says Windle, "that the chemical constitution of living matter, as far as we know it, does not in any way help us to understand its possibilities."[5] This uncertainty makes the pediatrician feel more or less secure against criticism in airing his clinical experiences and research.

Hertwig finds that the work of the investigator of the peculiar problems of life begins where that of the chemist ends. Above the growth of the chemical molecules is placed the growth of the cell, and still above this is placed the growth of plants and animals with their union of millions of different cells. He adds that chemical knowledge as it exists today has nothing to do with the new world of organized substances in which the manifestations of life are first made obvious.

As the living cell derives its food from many sources and from this food builds and rebuilds its own substances, utilizing the materials which it assimilates for its own uses and purposes, this process of assimilation, although in some measure chemical, is better described as bio-chemical.

ESSENTIALS OF PROTOPLASM

Reinke, in making investigations into the chemical nature of protoplasm by experimentation with the lowly amoeba, succeeded in picking out the following chemical compounds. In addition to essentials already enumerated, he found salt, the carbonate of lime and of iron, the phosphates of ammonia, of magnesia, glycerin, free carbonic acid, linked amino-acids, myosin, egg albumin, pigments, grape sugar, nucleoprotein, and calcium, all ingredients of the soma or body cells.

Unfortunately the precise combinations of these, their mutual linkages, and their relations, are unknown to us. However, the meagre knowledge at our disposal aids the pediatrician in suggesting foods in which these elements are found, or from which they are derived. In this cell protoplasm, fat, protein, sugar, starch, soap, and salt globules are all in harmony, but remain strictly separated from each other by the chamber walls. Between these walls the solutions of the substances are flowing, and each chamber, each droplet, absorbs from them those substances which are chemically related to its own contents. One wall is permeable to salt solutions and accumulates salts within itself; another allows the sugar molecules to pass in and composes starch from them; a third wall aids in building protein from the amino-acids, while a fourth helps to manufacture soap from

potassium. Each minute chamber is living a limited existence and each cell is a chemical factor.

This is called the *Comb Theory.* A minute cell is supposed to be composed of 20,000 combs, which in turn are composed of the many elements and compounds already enumerated, as well as many others.

Protoplasm breathes by taking in oxygen from the air, collecting it, splitting up the oxygen molecules into their two atoms, and introducing them into the combinations of its living matter. It feeds by absorbing water and salts, sugar and acids, alcohol and fats, as well as protein bodies. Protoplasm, too, possesses specific substances for dissolving the sugar molecules and others specifically adapted to each of the various proteins. With the aid of these substances, it dissolves albumin into combinations of amino-acids, and these combinations, in turn, into their individual components, the amino-acids, starch into dextrin, dextrin into malt sugar, malt sugar into grape sugar, and grape sugar into carbonic acid and water. The fats, it splits into glycerin and acids, and these are further dissolved. From the components of these combinations, in turn, protoplasm is able to build up hundreds of different substances with the aid of specific chemicals. From the amino-acids, for instance, the tiny cell builds amino-acid compounds again, and from these, protein molecules of various kinds, which it couples with an endless number of minor substances as required for specific purposes. From acids and glycerin in particular, it compounds wholly unique cellular fats. These it ties to phosphorus acids and to other bodies, thus building the various lecithins and other phosphoric fats. From the low orders of sugars, it composes the higher ones, and these in turn form dextrin and starch. This cell mechanism goes on without interruption, in order to maintain and increase the protoplasm, which is continuously disintegrating. Parts of the compounds thus created are stored by this living matter at definite places, as a reserve to be oxidized at a proper time or to be utilized in performing special work even more complicated than carrying on the more simple activities of life.[6]

GERM AND SOMATIC CELLS

At the stage of the fertilization of the egg, the individual consists entirely of germ cells. As embryonic development proceeds by the division of this egg, of this first cell, all the cells may at first retain the power of reproduction by division, which, however, they later lose. Neither they nor their descendants can

ever produce a new individual. Such cells are the body cells, or somatic cells. As time goes on their descendants outnumber by far those cells which retain the power of reproduction, and in consequence the body becomes much larger than the reproductive organs which contain the germ cells. The germ cells are in a position of superiority, of genetic independence and autocracy, and in each generation give rise to other germ cells as well as to somatic cells.

Germ cells have, then, this degree of independence, for while they are dependent for nutrition upon the body cells which contain them, they are superior to them. These somatic cells, the basis of the child's body up to a certain stage, give rise by division to other somatic cells; but they do not, with a few supposed exceptions, give rise to germ cells. Thus, while the body cells may influence the germ cells physiologically, they cannot alter them by producing new germ cells of a different kind. In fact, such somatic cells may be regarded as a part of the environment of the germ plasm. To what extent the products of the germ cells are modified by such somatic influences is probably not definitely known.[17]

In multicellular organisms, therefore, the germ cells are of the same construction as are the basal body cells. The former produce new organisms by their repeated division, while the others, in vast preponderance, build up the body, or soma, which forms a protection for the germ cells. Probably much more than the germ cells, the body cells possess a high degree of adaptability to external conditions and are modified to fit them. Thus we find the soma a mass of protective cells that are capable of a high degree of specialization and able to adapt themselves to the needs of every possible environment of our children. Old organs are readapted to new uses or are retained as merely functionless rudiments, for example, the appendix. New organs arise through the changes of function of some pre-existing part. In fact, the body in all its details has been molded and shaped with each new change into producing the highest degree of physiologic efficiency. Differences in environmental factors, such as changed nutrition, may cause modifications in the digestive system. All the surfaces of the body exposed to the air, for example, develop glands to resist the sun and wind.[4]

NORMAL ACTIVITIES OF CELLS

(1) *Oxidation,* a burning up of food material. The cell reintegrates by the addition of this new matter. Among the most

fundamental of the dynamic chemical events in their relation to life, are the oxidations, which yield energy to the cell and which intimately depend upon the influence of molecular oxygen. A great biologic advance was made when water was found to take an important part in the processes involved. The biologic importance of the peculiar physical and chemical properties can be seen from whatever standpoint we consider the dynamics of the living cell. Food stuffs consist of three quarter parts of water, and the direct oxidizing agent in the cell is the oxygen of the water.[8]

(2) *Energy,* which implies combustion by oxidation, a chemical disintegration of the completely organized protoplasm, and of its reduction into more highly oxidized but simple compounds, such, for example, as carbonicoxide and water. Protoplasm makes good its loss as rapidly as it occurs, provided it has sufficient material to act upon.[3] The energy of the cell is often attributed to nutrition and to its environmental factors alone. In truth, nutrition does play a great part, for without it there could be no foundation for energy production. One can never be quite sure whether this cell energy is entirely due to nutrition and to its attributes, such as sunlight, water, and the different elements and gases contained within its confines. It may be that certain cosmic forces, such as the phenomena of radioactivity, have an enormous influence. Elements like radium and uranium undergo a change in the nature of an explosion, and liberate a form of heat. In fact, radioactive material is scattered far and wide through the crust of the earth. Elements of which we know nothing may exist in abundance.

There must be some gigantic natural force, for the little cell never rests and is always awake, as we understand the meaning of the word. Cell oxidation may well be likened to the action of a lump of coal which transforms the fire box of the locomotive into a chemical laboratory and releases its energy as heat. Green plants, too, can trap the sunlight and utilize its energy to build up their composite bodies. The main activity of living matter, then, is the production of, storage, and utilization of energy. It is this parallelism between the metabolism of the child's organism and that of the plant which impresses us with the belief that nature designed the fundamental food principles of the plant to be the chief elements in the nutrition of the child.

Every animal and every plant depends for its life on the maintenance of this supply of energy. Moreover, fundamentally, the energy of the child is dependent upon the energy of the plant. Both plant and child must be looked upon in a sense

as a complete and extremely delicate piece of mechanism which is constantly employed in collecting energy directly or indirectly from the sun's rays in order to maintain a continuous struggle against the destructive forces of its environment. In truth, life, like a flame, is a manifestation of energy. The plant, through the medium of its green coloring matter, traps the energy of the sun's rays and uses it in the formation of complex chemical compounds manufactured from very simple raw materials derived from the soil and air. The animal picks up the plant at about this stage, consumes it with its store of chemical energy. "Back to nature" and to "nutrition close to the ground" are very fitting slogans to remember in infant and child nutrition.

Within the child's body the compounds of the plant are broken down into simpler ones by the living mechanism of the animal, and the energy freed in the process is used to maintain the child's body at a temperature above that of its surroundings, as well as to provide the motive power for its bodily and mental activities. In infant and child nutrition we must revert to the source of all nutrition from the plant, for they feed on animals which procure their nourishment from the field. The question, "what makes the cell operate," is, of course, to be answered by no one upon this earth.[9] Man has difficulty in accounting for the power which directs and initiates those chemical-physical processes in the living organism. Professor B. Moore speaks of what he calls "biotic energy," an energy which, in the presence of the proper and adapted energy transformer, the living cell, is capable of being converted into the various adaptations of these other forms of energy. It is, moreover, perfectly clear to pediatricians, from their intimate and everyday experiences, that conscious human life and the processes which take place in living matter influence life itself, or the vital principle, and do in reality modify the forces, energies, and movements of matter. In addition, as Windle points out, it is obvious that war, fever, religious revivals, and other emotional excitements all exercise potent influences over the energies and movements of matter. There is a directive power over this material activity which is represented on earth by the fervent and deep emotional religious feelings of the people. It is very clear that such deep emotional responses may modify the direction of a biologic force without altering the quantity of its energy or adding to the work done.

The expenditure of energy which accompanies all vital actions is based on chemical changes, and the usual explanation of the increased activity of an organ is that it is due to an increase in their chemical changes. If, therefore, we recognize that such

agents as heat and cold, chemicals, and the toxins of disease, can increase or decrease the activity of certain living structures, there remain other agents capable of exerting similar effects. Or perhaps it is better to say that other agents intervene between the heat and cold and chemicals and the other organs which are influenced by them. These agents, says Mackenzie, are obscure and most difficult to understand. Such an agent might conceivably be a stimulus or an impulse. Recently pediatricians have been employing electric currents and other artificial means of stimulation in disease with excellent results. The reactions which have been obtained by these mechanical means are frequently accepted as the equivalents to the reactions seen in the normal healthy body of the child and may be described as physiologic. The natural impulse is that cell impulse which nature employs to stimulate or to retard the activities of an organ. It is a force in nature that we know exists but which is not of itself susceptible of analysis. We know absolutely, however, that the effects which the impulse produces are vital activities.

The living cell is never at rest, but the time occupied by the discharge of energy is constant and probably momentary, while the time occupied in the renewal of energy is variable. Undoubtedly metabolism plays an important role. Its increased activity is due to a diminution of the period of renewal and, conversely, a decreased activity is due to a lengthening of this period.

Therefore, agents which affect the activity of a cell act either by shortening or lengthening this period of renewal. To explain what we mean by the nature of a cell impulse, let us turn to a rather pretty illustration in the vegetable kingdom, to a flower called the Venus' flytrap or Dionaea muscipula. A fly alighting upon the leaf starts a series of impulses of contraction. In order to have this come about, all the cells of the plant must act in unison through their impulses. The stimulus produced by the fly could only have affected directly those cells in actual contact.

One may visualize a similar situation in the child from the effects of light, sunshine, water, nutrition, and other environmental conditions. Within the flytrap we see a series of cells performing quite dissimilar tasks. When the fly has been digested and absorbed, other cells relax the leaves and they return to their original form for catching other flies. In this manner, the cells control, relax, inhibit, contract; each cell performing its allotted task much in the same way as do the cells which make up the child's organism. We can visualize a cell delayed in the renewal of its natural forces through improper nutrition and for other reasons. There is an action of relays of the cells con-

tinually succeeding one another in discharging energy in the form of contraction. In what is called "stimulation" of an organ, a great number of cells are called into increased activity, and normally these cells are so regulated that purposeful movements or functions are executed.

When any organ of the child's body is not acting under stimulation, fewer cells are in action at a given time. Through this variation in organ activity, a "control" operates so that the function of the organ or organs is graded in intensity so that they meet the various calls made upon them.[10]

(3) *Irritability,* one of the most important attributes of the cell, is that property of living substance by which it responds to stimulation.

(4) *Food Storage* is of great importance also. The reserve food of animals is stored in specialized connective tissue cells scattered throughout the body or else localized in the so-called fat bodies. A small supply of fat occurs as minute droplets in all tissue cells. Reserve carbohydrates occur in the tissue cells, chiefly as granules of glycogen. Reserves of protein are found in the protoplasm itself or in an inactive form in special storage bodies.[11]

(5) *Electric Currents in the Cell*

With every activity of each living cell in the child's organism there are associated innumerable electric currents, and the continual changes in cellular potential and the passing of minute electric currents hither and thither act as regulators and messengers of the polyplastic and protoplasmic system of the cell. Thus do they regulate and control every activity of the body.[12]

Protoplasm is in constant activity, for *oxidation, assimilation,* and the *rejection of waste* are constantly going on. Deprive the cell of food or oxygen and it dies and begins to break up; the autolytic enzymes begin to hydrolyse and break down the dead protoplasm. Such a cell requires constant oxidation; it is like a battery constantly running down and requiring constant charging. Irritability is so important that if there is lacking a balance of cell metabolism, exhaustion and death may follow. Since all the reactions of irritability are associated with more or less expenditure of energy, normal or abnormal, they all result in metabolic disturbances and are all associated with chemical changes.

We are led to believe that the chemical activities of living matter are the source of the energy of all vital phenomena and therefore are physico-chemical in their nature. When we inquire into the meaning of the continuous activity of the normal child's

life as contrasted with the temporary suspended activity of fa tigue, or the permanent suspension of death, we find it al explicable through the study of metabolism, the self-sustainin power of the organism. In a cell we have a large number o comparatively simple compounds, the elements of which shoul be contained in the nutrition of the child, and which all col lectively form the protoplasm. Thus the child's life, in reality is the presence of a number of such organic compounds capabl of mutually reacting upon one another and thereby giving ris to new compounds, which, however, cannot react chemicall with the mother substance from which they are derived. Inci dentally it would seem that many research workers interpret the formula of cell composition differently. McFarland finds cell protoplasm to consist of carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, potassium, calcium, magnesium, and iron, but besides these there are undoubtedly many compounds of which we know little or nothing. Living substances, either animal or vegetable, require at least ten elementary bodies for the elaboration of their tissues; and, the writer believes, a great many in addition. It is evident that such bodies cannot perform their vital functions when the supply of these elements fails, but they cannot fail if the nutrition of the child is composed of a large number of these food nutrients, a far greater number, clinical experience seems to show, than is found in the average diet of any one people. Irritability, it should be remembered, does not imply an expenditure of energy disproportionate to the force of the irritation agent.[3]

PHYSIOLOGIC NEEDS OF CELLS

Cells are immersed in a fluid composed of salts and crystalloids which also contains colloidal particles, as in the plasma, lymph, etc. In the maintenance of the equilibrium of these cells in the child's organism, three important factors must be considered in the selection of the substances to be used in cellular nutrition. First is the selection of appropriate food; second is the selective action of the membranes of the digestive tract, allowing the passage into the blood of certain substances which have been transformed into more simple compounds; and third the selective action of the cell membrane, absorbing certain substances and rejecting others which in turn must be eliminated by the lungs, skin, kidneys, and intestines. The process of fragmentation and the selective passage through the different membranes are essen-

tial to the proper maintenance of the cells composing the tissues and organs.

The membrane of certain cells will admit the penetration of certain colloid substances. If these are compatible with the plasma of the cell some of them will be assimilated without appreciable change in the nutritive equilibrium. If, on the other hand, the substances have some incompatibility, the equilibrium is of necessity changed and at once a physico-chemical reaction takes place both in the invaded cell and in the invading substance; and then we see a marked disturbance which, extending at least theoretically from one cell to a mass of cells, contributes a condition which prevents the cells from proper repair work and from establishing the proper development of an organ or organs, thereby possibly causing a dysfunction of the child's whole organism. This is one of the interesting problems which the clinician faces when he studies nutrition and the selection of foods.

This disturbance in equilibrium, or, in other words, in metabolic balance, probably determines the formation and expulsion beyond the protecting membrane of antibodies, the presence of antigens in the circulation, and, in consequence, the phenomena of anaphylaxis, etc. In fact, Sherwood, Dunn, and others believe that all forms of chronic diseases and symptomatic manifestations of non-contagious origin appearing in the human subject are the results of a precipitate formed by the combination of an antibody with an antigen, and that the majority of symptoms are explained by the formation of this precipitate which obstructs the capillaries, causing a sudden break in nutritive balance in the cells of the various tissues but particularly in those of the nervous system.

The child's organic functioning power is lowered, for structural development is impaired, and thus physicians find all types of dysfunction. However, vital activities cannot be governed by the rules of simple chemistry. There exist factors which modify all these processes, many of which are as yet unknown. It would be illogical, then, to try to use these unrecognized conditions as guide posts in the great biologic problems of nutrition and development. Be that as it may, medical men enjoy enough biologic knowledge to warrant the establishment of proper nutrition for growth and repair.[13]

The cell is an organic machine, so to speak, animated by a psychic nucleus, and its activities are increased or lowered by the stimuli arising from the psychic center. Its cytoplastic activity

does not go beyond the power of metabolism to keep the machine of the child's organism going, for this cytoplasm feeds on the many end products of metabolism.

It must not be thought that the cell changes dead into living matter through metabolism, for in this latter process the food particles which it absorbs from the blood are used to produce the mechanical and chemical transformation of energy which keeps this little machine running. Its activity is so directed, initiated, or graded that it will produce the sensations, thrills, and satisfactions demanded by the psychic center. The cell may respond in different ways to stimuli, but, being a well organized structure, it retains complete self-control at all times. It may ignore the stimulus or merely arrest the response or change its course after once being enlisted. Following a response to one stimulus it can reset its mechanism and be ready for another again and again. Physical energy is thus used up and metabolism replenishes the fuel to restore the loss.

If a child's cells are too badly adjusted to his surroundings, if they cannot orientate themselves to their environment, they must of necessity perish.[14] The struggle of the cell to meet the demands made upon it by the individual is tremendous. This cellular activity, when disturbed, causes irregular conditions to manifest themselves in the child's nerves, brain, skin, muscles, or other organs. The cell struggles against the metabolized end products of badly selected and unphysiologic food material. Its functions also are influenced by such emotional stimuli as life usually brings to human beings, for it suffers from care, worry, grief, fatigue, starvation, and excessive thirst, and also from those severe emotional reactions of fear, jealousy, anger, and rage. It is hampered indirectly by environmental physical conditions such as lack of sunlight and fresh air, as well as temperature changes. Barometric pressure and electrical conditions in the atmosphere have been known to bring about changes.[15]

All cells need first a constant supply of reparative and building material as well as material for kinetic energy, which is furnished to them as dissolved digested food. Oxygen is obtained from the blood stream. There are chemical messengers from the endocrines, from the internal secretions, and from the antitoxins. Second, there must be a constant outflow from the cells, draining off an excess of blood whereby wastes and formed products are removed; this is the duty of the lymph channels and of the nervous system. Third, there must be a coordination of all these forces through vibratory messages from the cerebrospinal sympathetic nervous system.[16]

CELL NUTRITION

The most important factor in our study of the life of the cell is its nutrition. This is derived from the food constituents carried by the blood stream. If the normal composition of the blood is in any way depleted, or if, for some reason, abnormal constituents have entered its stream, only the cells ordinarily deriving their nourishment from these impaired or abnormal constituents are affected. These cells are, in consequence, weakened, their activities impaired, and they, in turn, produce defective cells which lead to disordered organs and tissues as well as to abnormal secretions. It stands to reason that this generalized impairment of the organism could have been averted in many cases by a balanced and proper food intake, and that an improvement in the existing condition will have to be brought about by a correction of the nutrients which caused the initial disturbance. The child's organs and tissues will tend to regain a normal growth if parts that have fallen into derangement or into partial disuse are replaced by improved cells through reproduction. If, as the child grows older, nutritional and environmental harmony is not brought about, perhaps because of the ignorance on the part of the parents, or perhaps because of economic vicissitudes, many cells retrogress and become unsuited to the available nutrition and to their surroundings. If the child's nutrition is extremely faulty, cell disturbance proceeds apace and reproduction is hindered.

One must always bear in mind that an improved metabolism means that the cell is trying to retrieve itself, a thing hard to do if it has been unwarrantably abused. In old age, the cell must be particularly considered and the food of the aged must of necessity be very different from that of younger generations.

In childhood, the reproduction of cells takes place much faster and is potentially more effective than in old age, for the child's nourishment and surroundings are better fitted for impressive cell manufacture.[17] When a cell is well nourished and vigorous it gains the power of storing or of utilizing more food material.[18] When this food material from the blood is made over into cell substance, the cell can be pictured as stronger or even larger, having, therefore, increased affinity for the same food substances. The more food the cell utilizes in its metabolic activities, the more it can use.

CELL FUNCTION

Even though each organ of the child's body has a recognizable function of its own, it can never be considered as a unit within itself, for every organ must function in conjunction with one or more other organs in order to establish any of the great systems of the body, such as the respiratory, circulatory, etc. Therefore the system functions through the functions of the organs which compose it, plus certain activities which depend on the close correlation of the organs. The basis of these organs, all so mutually correlated, is the cell, and the type of the cell may be different in the various organs as well as in the same organ. Many cells, indeed, do not share equally in determining the function of the whole organ. However, certain cells may directly perform the service to which the organ is devoted. For example, in the stomach the function of the cells of the mucous layer is of greater and more immediate importance than are the functions of the other cells of that organ, although these other cells are indirectly indispensable.

One can postulate that different types of cells serving different organs or establishing different functions of a given organ must draw quite different food principles from the blood stream. The physiology of an organ is, however, more than the mere function of its cells, since in cooperating the cells modify the performance of one another and there results a function of that organ as a whole which rests on the function of its parts.[11] It is generally conceded by authorities that the functions of these highly specialized cells or organs are to be found in a rudimentary form in primitive cells. The student may believe that such primitive cells must require simple elementary foods. It is a fact that at a certain stage of development all cells of the child's body are similar in structure and function. In the course of development, however, these cells become specialized for particular functions, gradually losing their power to perform other functions. Nevertheless, this specialization does not affect the fundamental fact that function itself can be modified only by influences which tend to increase or decrease or regulate its intensity.

The most striking example of specialized cells in the animal body is the nerve cell. While some nerve cells are specialized for sensation and ideation, those which constitute the nerves of the child's organism in general have but very simple functions to perform, of which perhaps the most important is the serving as a means of communication between organs. It is surprising

to realize that the actual cell body probably takes no part in these processes but is concerned apparently only with the nutrition of the whole structure. Biologically the receptor and the discharging fibril play a prominent part in that they receive and discharge impulses. When an impulse has been discharged, some time elapses before a second discharge can take place, for the energy of the cell must be renewed. These receptor fibrils have been especially developed for the taking up of impulses from other cells.[10]

The discharging fibrils evidently give their peculiar character to each impulse, which, incidentally, means their character as an accelerator or as a retarder of the renewal of energy in the cell. The sympathetic and the vagus nerves are illustrations in point. It is in this way that the agents of disease and drugs exert their influences both on the receptor and on the discharging fibril. Thus, for example, digitalis increases the excitability of the receptor fibril of the vagus, while atropin decreases the excitability of the receptor fibril of the vagus and decreases the excitability of the discharging fibrils.

When a cell normally performs its functions, when it contracts it discharges an impulse at the same time. This combination of functions is found, for example, in the auriculo-ventricular bundle of the heart. The skin, too, is composed of a great mass of living cells and when a light body or rays of sunshine strike it the cells are stimulated to activity and pass on impulses which travel from cell to cell until the receptor fibrils of the afferent nerves are reached. As the function of the cells consists of either discharging or renewing energy, the varying effects of this cell activity are of great interest to students of physiology.

When cells are grouped to form an organ, their activity is regulated and controlled. In discharging energy, cells exhibit their peculiar functions (contraction, secretion, sensation) and at the same time discharge an impulse. This impulse exerts an influence upon the neighboring cells by increasing or delaying the period of the renewal of energy.

Disease symptoms in our children are therefore due to a disturbance of some element of the reflex arc.[10] And if the pediatrician has a thorough working knowledge of the anatomy and physiology of the nervous system, often obscure symptoms may be traced to their source in or about a certain organ or organs.

The liver cell accomplishes some twenty tasks inside of a quarter of an hour. Through the liver, after meals, the juices

of the digested foods flow with the blood. From this passing blood stream the liver cell absorbs the chemical compounds of the nutrients which have been ingested. It takes the sugar from the sugar molecules and from it composes starch, which paradoxically it dissolves again into sugar. It absorbs the amino-acids of the dissolved protein molecules and combines them with ammonia, producing urea and uric acid. These it couples with the metals in the body, potash and soda, producing urates. Furthermore, the cell takes from the blood the hemoglobin of the ten thousand billions of blood cells which are daily dying and changes it into the greenish bile coloring matter. From those fundamental compounds which are as yet unknown to science, it builds up the fellic acid which it attaches to the amino-acids.

The poisons given off in the intestines in digesting protein, such as carbonic acid, it accumulates within itself, rendering them harmless by uniting them with sulphuric acid. With such poisons as carbolic and sulphuric acids, the liver is operating every day. This organ never poisons itself, yet it controls many poisons, such as caffein in coffee, nicotine in tobacco, morphine, opium, veronal, and others, dissolving or tying them up, thus making harmless substances of them when not in excess.

From a great variety of chemicals it brews the bile, an elixir composed of more than thirty different infusions and essences. With all this multiplicity of tasks, the cell never dies, for it keeps on splitting.

What is true for the liver cell is equally true of every one of the 30,000 billion cells of the child's organism, its soma. The kidney cell builds urea from the blood, the intestinal cell absorbs food stuffs, the stomach cell manufactures hydrochloric acid and pepsin, the heart cell contracts 100,000 times every day, and the brain cell perceives sensations or produces thought. All the protoplasm of these cells must have special nutrition to function, and it becomes the obligation of the pediatrician to advise such nutrition. Thirty thousand billions of living cells in the child's body are constantly active. They may be said, profanely, to be hopping and halting, flowing and creeping, building and brewing, seeing and hearing, feeling, thinking, and knowing, and yet, like our favorite dog, they cannot tell us what they need as to foods.[6] The child is but the cell, the cell is fundamentally but nutrition, and nutrition is in reality but what the pediatrician or the guardian, wise or ignorant, selects for it. The child's health or illness, its happiness or misery, its life or death, all revert to the cell and, therefore, to nutrition.

THEORIES OF THE RELATION OF CELLS TO FOODS AND TOXINS

The cell may assimilate toxic material from the blood as well as from food. Toxins injure certain cells and not others because they have a chemical affinity for those particular cells and not for others, and it is often only symptomatically that one can ascertain which cells are injured. This difference in chemical affinity would seem to explain why it is mainly nerve tissue that is destroyed in lockjaw and in infantile paralysis, while diphtheria toxins, on the other hand, may combine with many different types of cells. This chemical affinity doubtless is the same as that which influences the cell in its selection and utilization of food materials. Thus it would appear as if one food element could be combined with a given cell and utilized, while a second nutrient might not be able to combine with that same cell or be assimilated by it. This theory is the basis of the writer's insistence on a broader dietary for children.

Now, since toxins are more or less protein in character, it is quite possible that a given toxin may have the same chemical affinity for a cell as a given food protein, which rather complicates matters. If then such a toxin be combined with a cell, at least two injurious effects would be exerted upon that cell. First the toxins would prevent the normal combination with the special food element at hand whose place it has taken; second its chemically irritating poisons would be brought into intimate association with the cell, disturbing or destroying it. The problem of the physician, then, would seem to be a substitution of the toxin by innocuous food proteins, a question of proper metabolism.

The more food protein the cell utilizes, the more it can assimilate. Undoubtedly this holds true equally with a protein poison. Postulating that certain poisons unite with certain combining factors of a cell, they then must be alike. It is from the food elements called receptors, which are found in the blood or lymph, that we get different types of defensive forces. Such may be, for instance, the autotoxins acting on the bacterial cells, or perhaps other substances which are given special names depending on the way they affect the bacteria; for instance, lysins if they dissolve bacteria, agglutinins if they clump these bacteria.[18]

THE POSSIBILITY OF LABORATORY PROTOPLASM OR ARTIFICIAL PROTOPLASM

Were it possible for us to know everything about the composition of protoplasm, were it possible to manufacture this living matter in the laboratory, the problems of every pediatrician would be lightened. He could, were he so inclined, collect enough biologic elements, charge them with electricity, and create life. Having created life, with a comparatively few requisites he might add to the life created all the food-stuffs and end-products necessary to growth and repair. At any rate, it is one thing to create life but quite another to endow that life with all the essential food elements.

It has long been the dream of biologists and bio-chemists to create life artificially. Many scientists have wrestled with the idea that at some time life can be in reality thus produced. Sir Oliver Lodge, in a lecture at Oxford University on June 3, 1927, maintained that the artificial creation of life is not an impossibility but, from some points of view, inevitable. Many compounds found in living organisms or secreted by them have been made in the laboratory, as, for instance, urea, sugar, and starch.

It is sometimes said by students of organic chemistry and by bio-chemists who have studied protoplasm, that if we could contrive in the laboratory to continue the manufacture of these organic compounds until we had a mass of protoplasm, and were able to subject it to suitable pressure, we could expect the artificial product to exhibit vitality and to manifest another form of life. This planet of ours was once a molten mass, yet living things have since appeared on it.[19]

Protoplasm may draw its energy from the cosmic forces which surround us. All this, while bearing no relationship to the work of the pediatrician, at least encourages him in the belief that health and growth date from proper nutrition and that longevity may also be linked to it.

The knowledge of the general features of protoplasm aids us in a primary way to an understanding of the child's development. We must consider, then, that chromatin, which comprises at least part of the cell's nucleus, is the very substance of inheritable characteristics respectively of the tendencies, traits, potentialities, etc., which during the period of development grow into mature characters.

In passing from the fertilized egg to adulthood, the child goes through a series of changes. In the course of this development we not only see the beginning of the organs which gradually

enlarge and change in their structural and functional development, but we also recognize the fact that some organs disappear, some cause marked dysfunction, some grow smaller, and some unsuspected mental and physical characters stand out.[20] Characters are only potential and not actual in the fertilized egg, and their development depends upon many complicated factors of their transmission and environment. None of our children can hope to express fully every quality in their heredity. Every previous dysfunction or normal function of parental or ancestral organs, also every growth impulse and every organ with which their progenitors were endowed, are potential factors of development.[21]

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CHAPTER 4

DISEASE

HEREDITARY AND ENVIRONMENTAL FACTORS

Disease, with its synonymous terms, defect, derangement, and disturbance, may be considered, in general, as any marked deviation in form or in function from the standard of normality as we understand it. Any novel character when it first appears is abnormal, but it may be given an opportunity for further development; or it may be the expression of disharmony, which damns its exhibitors. Disease, at best, can be but a relative conception, and therefore does not admit of a strict definition, since that which is abnormal in the case of one child or of one organ or even of one tissue may be quite normal in another. Then, too, disease may be a disturbance which has no characterization essentially different from that of normality; it merely means that these characters are presented in a totally different and less useful order. All inherited abnormal characters are to be regarded as the results of the interference of genetic factors in the normal series of events in the process of development. There is therefore a physical basis for all abnormal characters and in all cases the abnormality results from a definite disharmony in the processes of development.

Indeed, it would seem that the genes, the hereditary factors, coming into action serially, tend to release physiologic agencies which specifically affect development. If, for example, there are those factors which determine the time at which the pituitary, the thyroid, or the adrenals come into action during development, and which determine the rate of their functioning, then a mutation or change-about can result in profound disturbances in any one or all of them. One can parallel this illustration with the functioning activities of any body organ or tissue. The list of heritable abnormalities and irregularities as seen in children is a large one. It may be in many instances dominance and recessivity are not the true meanings of normality or of abnormality in our children. It is possible that, in addition to the particular hereditary factor responsible for this abnormal condition, there may be several accessory genes which, in their dominant action, modify the action of the principal factors, affecting

the degree and direction of their action. Many abnormal characters of brain or body are seen to arise even under normal stimuli. Sometimes these abnormalities do not appear until maturity or even old age. Others require pathologic environmental stimuli to flower, and if these are lacking the disharmonies do not develop. We know that many such abnormalities are brought about through the endocrines. It follows, therefore, that the organism of the child would be entirely changed biologically and emotionally, the signs of which would reveal themselves as some body unbalance or as some form of psychologic unrest. If, therefore, the child's brain and body are not balanced in respect to heredity and environment, disease, infirmity, or death may follow.[1]

In this body balance of the child in health and unbalance in disease, the psychologic forces exert a strong influence, for in the latter case the correlating mechanism of the body cannot function normally.[2] One sees early in children the stigmata of pathologic mental processes, some mild, some severe, some corrected and obliterated through environment, but others not affected, or if so, only in a moderate way. Many psychologic conditions which refer back to heredity cannot always be demonstrated. They do react to environment but have no important genetic significance. Such mental aberrations as neurasthenia, psychoasthenia, and hysteria may however represent a faulty germ plasm. These disturbances may be seen in adolescence in emotional girls. Epilepsy may also be ranked among this group, and mongolian idiocy is decidedly found there.[3] Many forms of insanity tend to run in family groups, for the transmission of hereditary diseased characters transplants but the same soil in the new generation. The fact remains, however, that we have no definite or positive means of knowing just how such diseased soil is transmitted, for accurate information is often impossible. Times have changed, and the opinion of to-day is that tuberculosis and syphilis are not hereditary. Nervous diseases of a potential metabolic unbalance, musculatrophy in its many forms, the many variations of color-blindness, amaurotic idiocy, sporadic goitre and its complications, cretinism, Basedow's disease, and many forms of deaf-mutism, all spring from disorderly heritage.[4]

In our study of the inheritance of characters we often employ the terms genotype and phenotype. The former denotes the fundamental constitution of an organism with all its hereditary peculiarities; the latter signifies all the individuals having the same characters, these phenotypical characters being determined

by both the geno-typical impulses and by environmental or para-typical conditions.

Thus disease may be considered as any deviation from the normal in development, in form, or in functioning of the phenotype.[5] Still again we might define disease as an injury to the infant or child in consequence of which its functional capacity is impaired. For whether one or more organs are pathologically affected, there always results a depression of some bodily or mental function, due to changes in the structure and in the composition of the tissues when the whole balanced metabolism of the body and brain is thrown out of gear, and then what we call disease makes its entry. To speak in simpler language, disease is the sum total of the depression of bodily and mental function. We can conceive of hereditary and somatic diseases as being quite separate entities, the one form arising from the germ plasm, the other from environment, but in our conception a large percentage of diseases have their inception in heredity, at least the characteristically impressive ones. On the other hand, however healthily endowed a child is, a faulty environment, such as excessive heat and cold, abnormal conditions of nutrition, poisons, microorganisms of one kind or another, contribute to form the backbone of hyper-, hypo-, and dysfunction. Unfavorable environmental influences may induce abnormal conditions of various types, for an injured organ cannot work as before and other organs must take up its burdens, which often they are unable to do.[6]

Students of heredity understand the significance as well as the limitations of heredity in disease and realize the interaction of the germ plasm and environment. If the germ plasm is normal and the environmental stimuli likewise, a sound organism results. If this germ plasm is abnormal, or if the environmental stimuli alone are abnormal, disease is inescapable, and if a combination of both forces arises, there results chronic disease or death.[7] Neo-Darwinians deny the direct inheritance of disease, for, they say, what is in reality inherited is a weakness of resistance toward, or an active propensity to, a particular disease. Diseases, they add, are caused by pathogenic bacteria and they cannot be an integral part of either the ovum or the sperm.[8] Therefore, what is inherited is a lowered resistance which requires external stimuli to make the disease develop. Thus what is transmitted to the child is a predisposition to disease. Indeed, the causation of disease in the child is not always as easy to diagnose as the laity and charlatans would have us believe. True, in many cases certain

types of disease seem to run in families, as either dominants or recessives, and are easy to diagnose, and perhaps to prognosticate and treat. But even here, it is often difficult for the pediatrician to distinguish whether causes spring from intrinsic or extrinsic sources.[2]

It is common to speak loosely of recurrent phases or conditions in children, such as "stomach troubles," as arising from faulty food intake; diarrhoea from polluted milk, pneumonia from sudden drafts, middle or internal ear disease from naso-pharyngeal malformations, cardiac irregularities from shock or from immoderate bodily activities. Yet other children living under more adverse conditions are affected by none of these. Are these children immune? Quite probably. People at large tend to place greater emphasis upon microorganisms, falls, shocks, drafts, faulty food, etc., than they do upon the sins, peculiarities, irregularities, and the "high society" living of the parents, grandparents, great-grandparents, even to the atavistic recessives of the great-great-grandparents, in spite of escutcheons Mayflower-ed, Norman Conquest-ed, Bourbon- and Hanover-ized. Alas! their virtues are remembered, but their vices are forgotten!

Probably many of the physical environmental agencies which directly or indirectly so strongly influence the life of the infant or child are those due to climate and temperature.[1] Such conditions affect the activities and the distribution of insects and of poisonous creatures of all kinds, as well as of the pathogenic life of disease germs, through temperature and humidity in the bodies of their hosts. Depressing climatic changes result in lowered mental and physical states and in the depression of the child's vitality and vigor, making him less resistant to disease.[1]

PREDISPOSITION TO DISEASE

The man on the street often speaks of a "disposition to disease," a condition which depends upon the abnormalities of the genotype or perhaps chiefly on the paratype, or upon a combination of both, such as is seen in a tubercular status. The genotype dispositioned child exhibits a long narrow thorax and very voluminous lungs, as contrasted with another having a short neck and thorax and small lungs. To offset the geno-, or constitutional type, the conditional, or paratypic dispositioned child is also encountered. If, for instance, this child has recently recovered from measles or whooping cough he stands in great danger of tuberculosis; while an asthenic, diathesitic child convalescent from measles has a combined hereditary and environ-

mental disposition to pulmonary tuberculosis and is therefore doubly endangered. Clinicians often describe several types of the general anomalies of the phenotype, such as the status asthenicus (Stiller); status thymico-lympaticus (Paltauf); status hypoplasticus (Barkee); status exudativus (Czerny); and status arthriticus, etc.[9] Under major divisions there may be found, of course, subdivisions.

While it is obvious that many diseases are not found in infancy or childhood, one cannot but feel that in the case of some of them their seeds are sown at an early age by heredity and subsequently developed by faulty environment. Among these diseases are recognized, sclerosis of the aorta, of the coronary and other arteries with sequelae, contracted kidney, gallstones, various dermatoses such as psoriasis, acne, furunculosis, prurigo, urticaria; also gastro-intestinal disturbances, neuroses, migraine, depressional conditions, arthritis, myalgic conditions, and rheumatic disturbances, which are seen to have kinship with the gout, diabetes, and obesity diatheses. Many of these pathologic irregularities are seen only when the organisms have reached maturity. However, an observant and experienced clinician will often note their forerunners in the heredity picture and the influences of environment on these danger signals. Often their signs do not appear before the third or fourth year, sometimes later, and they are commonly preceded by a latent period which masks their subsequent appearance. This period is deceptive, however, for at the earliest evidences of growth various peculiarities make their appearance. Although signs of actual idiosyncrasies may be lacking in very young children, such children are often unusually fat or thin, or mentally alert or irritable.

In the writer's experience, headaches, neuralgias, or pseudoneuralgias, sometimes periodic vomiting, and recurring attacks of fever or catarrh, have often appeared in older children from an undefined origin. Many children are also prone to dyspepsias of various kinds, are chronically constipated under the best hygienic and nutritional conditions, and suffer from piles. Also the skin seems hypersensitive to many affections arising from within the body. There is found as well a hypersensitization to eczema, pruritus, pemphigus, intermittent edema, and enuresis, the urine often showing a high specific gravity but little sediment. Although all these conditions may be influenced by heredity, their maturing surely is the result of environment and of unbalanced metabolism, and the dividing line is in many respects hard to draw.[10]

Paradoxically it may result in some good or in great harm.

Many individuals have grown to believe that all our ailments depend solely on inheritance and that environment exerts but a moderate control. This idea cannot be considered even in the breeding of plants and of lower animals, and surely then cannot be applied to the ills and diseases of children.[11]

As the pediatrician plods his daily rounds, he may half-consciously recognize human phenotypes in groups of children playing in the street.[12] Such types the French have divided into four main groups:—(1) the respiratory, (2) the digestive, (3) the muscular, and (4) the cerebral. Many individual anomalies of body are undoubtedly the signposts of special forms of organic and functional disease.[12] In reality one rarely meets these irregularities in a pure form, for they are an admixture of one or more forms, and the exact scientific establishment of any one pure form among them is exceedingly difficult, often quite impossible because of the many overlappings.[12] But each child tends to fall into some predestined orderliness or disorderliness of its organism, whether of very mild, moderately mild, or of severe form, according to its geno- or paratype.

It is the problem of the modern scientist to recognize these states and to regulate the child's life as to his nutrition and his physical and psychologic environmental necessities so that the organism may function well. As time goes on, more of these pathologic heirlooms will be recognized and in consequence more children saved.[9] Thus, in speaking of a disease diathesis one unconsciously considers the relationship between the child's constitution and his condition, a balance between what he has inherited and what good or bad possibilities surround him. When one remembers that the child's personality, the development of the mental and physical parts of his organism, can never be thoroughly established before maturity, it is not hard to believe that many diseases may come to full bloom only in later years. There are children, says Crew, who are predisposed from heredity to such pathologic conditions as peptic ulcer, chronic nephritis, pernicious anaemia, asthma, tuberculosis, gout, gall bladder affections, high blood pressure, urinary calculi, migraine, etc. It is entirely reasonable, he adds, to speak of diathetic states, or of a genetic tendency for the islands of Langerhans to undergo degeneration, or for many kinds of biochemical disharmonies to appear.[1]

Diatheses, indeed, may appear long after organic maturity. One cannot speak of a pure tubercular diathesis, as this poison damages the germ plasm as a poison only. Its bacilli cannot invade the germ cell and as such cannot be transmitted. A lowered

resistance to any disease may, however, ensue. An instance of this undoubted low resistance power, en masse, may be seen in Robert Louis Stevenson's book, *In the South Seas,* and of what may happen to a population when this dreaded curse with all its sequelae appears among it.[13] Today probably one of the most common, important and far-reaching of diatheses is that of rheumatism in its varied forms, ramifications, and sensitizations.[12] Indeed, Draper believes that certain of these sensitization phenomena are transmitted as dominant in quality.

Instances may be seen as certain forms of eczema and of urticaria, as asthma, as chronic rheumatism, as rheumatoid arthritis, and the like. He cites a history of 50 families, including several in which three generations are recorded and from which sensitization phenomena were tabulated. If, however, the second generation of each of these be looked upon as a separate family, then 60 families might be named with 234 offspring. Of these 234, 88 or 37.6 per cent were affected; of the 105 males, 37 or 35.2 per cent; of the 129 females, 52 or 39.5 per cent suffered. Draper showed that when the male parent was afflicted with rheumatism the percentage of affected male offspring was lowest, whereas when the male parent was not affected, the percentage of the sensitized sons with rheumatic fever was highest. Thus, in this disease as in many others, the fathers with rheumatism seem to impart a certain protection, possibly an immunity, to their sons. Another possibility arises, however, in that the character susceptible to rheumatic fever is a sex-linked one. Furthermore it will be observed that more than half the affected boys were those whose mothers had had rheumatic fever and whose fathers had not. When the father is rheumatic, it would seem that he transmits to the sons that something which offsets the possible sex-linked susceptibility character derived from the affected mother. This defense seems to be denied to daughters, who appear, from all points of view, to possess greater susceptibility to the disease. Remarkable as it may appear, Draper has found two cases in which the mother and father were not rheumatic, but the offspring were, suggesting the possibility that while the mother does not develop rheumatism, she may carry it as a recessive in a gene of her chromosome. There seems to be a strong indication that genetic influence determines the susceptibility of a person to rheumatism.

Parallel analogies may be cited as to the transmission of many other pathologic conditions.[14] These tendencies to disease are due to variations in the structure or in the composition of the developing organism. Certain diseases of the eye, such as errors

of refraction, short or far sightedness, astigmatism, suggest various forms of hereditary alterations; as do malformations in the structure of the eyeball, cataract appearing in the young, and night blindness, for these disorders transmitted down the genealogical line are often seen by the pediatrician before being allotted to the various specialists.[7]

The ancients knew this disposition to disease and Hippocrates spoke of four cardinal juices of body; namely, the mucus, the blood, and the yellow and black bile, whose normal admixture made possible temperaments and the disposition to disease. Galen first coined the phrase "constitutional pathology." Plato considered illness as arising from a condition analogous to the penetration of a parasite which has penetrated mankind and has carried on a self-supporting existence.[10]

Predisposition Test. In determining the method for the proper understanding of a disease predisposition, many favor the Diem-Kollersche test which rests upon the similarity of the tendencies of the sick and the well. It gives a dependable measure of a predisposition for a certain disease. Probably the best knowledge of the inheritance of an anomaly, apart from the knowledge of its congenital causation and of its hereditary course, is to examine into the illnesses of the mother during pregnancy.

TYPES OF BODY DISEASE

There are in general, then, three classes of diseases which may develop in the child's body.[7] First, the transmitted germ plasm of the individual may be practically normal with a good hereditary endowment but certain injurious influences may attack it from without, which may cause either directly or indirectly a disturbance in the structure, composition, and functioning. Second, a class of diseases may develop from an altered constitution of the germ plasm, necessarily of a hereditary character. However, as the germ plasm interacts with good or bad environment to fully mature its unit characters, those extrinsic factors also enter as a component cause. In the third class, the germ plasm is altered in an injurious direction, but here we find the change to be of a more delicate nature, for it requires, in order to become evident as a disease, the cooperation of certain cases. A child with an injured or somewhat abnormal germ plasm, may, to all intents and purposes, be normal if surrounded quite naturally by a healthy environment. But, on the other hand, a surplus or a deficiency of proper environmental factors might exist which, while in a person with a healthy germ plasm would

probably be without injurious consequences, in a less favored individual would result in disease.

In these pages we are interested in diseases into which both germ plasm and environment enter, but in each of which cases the alterations of the germ plasm and the character of the environmental factors responsible for disease vary.[7] Considering the fact that germ cells are cells without adult characteristics, it is impossible, says Conklin,[14] that any peculiarity of environment whether of nutrition, disease, or injury, which brings about certain peculiarities of the developed characters in the adult, could so change the structure of the germ cells as to cause them to produce this same character in subsequent generations in the absence of their extrinsic cause. How could rickets, he adds, due to defective nutrition, affect the germ cells, which contain no bones, or only the rudimentary principles of bone? Or again, how could over-exertion, producing hypertrophy of the heart, so affect the germ cells that they produce hypertrophied hearts in sequence, when they have no hearts? [14] With a patient under observation the pediatrician unconsciously, perhaps, asks of himself three questions:—First is the disease due to environmental factors or to changes in the germ plasm, or to both agencies? Second, if both such factors enter, how much is due to each, and what are the environmental conditions which come into play? Third, if heredity does play a part, wherein does the change in the germ plasm enter, and what is the character of the hereditary transmission? Still other and pertinent questions come to mind. Are the disease-producing factors recessive or dominant, are they atavistic, are they sex-linked, or do multiple factors underlie the condition of disease. At the present time our knowledge is not complete enough to answer all these questions, as the character of hereditary transmission and the changes in the transmitted germ plasm leading to disease in particular are, in many instances, in doubt. This is because of the difficulty in analyzing sufficiently the various matings in which a weakened germ plasm becomes manifest.

A final and most important consideration is whether the causation of disease is attributed to an altered germ plasm in particular and to what extent environment is responsible for the resulting inferiority. In this case, too, our knowledge is as yet incomplete. Loeb asks, "What part does heredity play in disease?" "If, for example," he says, "parents suffer from syphilis and the offspring shows evidences of this disease at birth, it merely means that the same micro-organisms which invaded the parent were transferred from this parent to the body of the child and that the

same disease found in the parent is present in that child." "Thus," continues this scientist, "the disease in the child was not due to faulty germ plasm but to an infection." [7]

FALSE CONCEPTIONS OF DISEASE TRANSMISSION

Many individuals still believe that a disease affecting one or both parents must be indisputably transmitted as such to the child. This is not necessarily the case.

For example, inflammation of the kidneys may be brought about in two ways. It may be due to the presence of microorganisms, or to substances which should have been eliminated by normal kidney action but which, when retained in the body, act as poisons. The germ may indeed suffer, yet it does not follow that what is injured in the germ will necessarily be the rudiments of the kidneys, so that in the developing child there will take place similar changes in the kidneys. It may be that the rudiments injured will be those of other organs, for instance the heart, stomach, etc. Thus the child of a parent suffering from kidney disease may perhaps suffer from some impairment of the mental functions or from any of a number of different diseases. Naturally it is conceivable that the poisons in question could attack the kidney rudiment. However, we may be reasonably certain that the result would be a kidney disease exactly the same in character as that from which the parent suffers. The fact remains, of course, that the parent contracted the disease from quite different causes. We are dealing in this case not with the transference of an organic change to the germ, but with the independent production of a disturbance in the kidney rudiment of the germ.

When the thyroid undergoes changes leading to Graves' disease, the chief effect is on the nervous system. If we accept the view that symptoms of disease arise in consequence of the production of abnormal substances by the thyroid, it is obvious that the germ may be injured and that the offspring would evince nervous conditions from the altered nervous system rudiment. It is, however, not possible that the rudiment of the thyroid gland in the germinal cell should be affected in the same way as the thyroid in the parent, so that the thyroid rudiment should undergo such a change as to induce subsequently the appearance of Graves' disease in the child.

Or again, when microorganisms give rise to an inflammation of the valves of the heart, this inflammation is not transmitted as

uch to the germ. It is, of course, possible that by chance the oxins produced by the microorganisms may injure this heart udiment of the germ plasm. The child then may have an abnormal heart, perhaps a congenital malformation of that organ, out it certainly will not have an inflammation of the cardiac alves, for such an inflammation is induced directly by microorganisms and by toxins. It is highly improbable, adds Ribbert, hat microorganisms invade the germs at all, but that they can act upon them only through their toxins. Consequently, if the toxins do produce their injurious effects at all they may be directed on ome other character-rudiment. Similar conditions apply to all nfectious diseases, as they are all alike injurious to the parental organism, to the germinal cells, and, in many cases, directly to the orain rudiment.[6]

MENDEL'S THEORY OF SEGREGATION IN DISEASE

We have been taught to believe in the orthodox truth of Mendel's findings but his theory of segregation seems to be valid in hereditary conditions only in part, for it appears to occur pathologically in the less severe types of disease, such as in minor anomalies and in certain malformations, rather than in the very severe and conspicuous disturbances. This theory can be applied possibly to hemophilia, to diabetes, and to certain mental disorders, but it apparently cannot be considered in severe mental aberrations. In slight cases of disease only one organ may be involved, but in more severe forms of germinal intoxication the whole body may be disturbed, therefore it would seem that complete segregation is not easy to understand. If one can conceive that the germinal intoxication may have affected whole series of separate characters, and also if one might imagine when segregation occurs that each of these characters behaves independently, the result would be that instead of all normal rudiments entering one germinal cell and all the abnormal rudiments entering the other, one germinal cell would receive some morbid characters while another cell would receive others. This would mean that all offspring are diseased in different ways and that none remain healthy.[6] In Mendel's fundamental law of segregation, the units contributed by each parent separate in the germ cells of the offspring and have no influence on each other. A simple illustration, as seen in the plant world, shows that in a cross between yellow-seeded and green-seeded peas, one parent contributes to the offspring a unit for yellow and the other parent a unit for green.

These units separate in the ripening of the germ cells of the off-spring so that half the germ cells are yellow producing and hal[f] green producing.[15]

DYSFUNCTION FROM VARIOUS CAUSES

When a poison such as alcohol affects the whole parental organ-ism and is distributed through all its parts, some of it will con-sistently reach the germinal cell and may conceivably influence the rudiments of the very organs which in the parent body are injured in their fully developed condition. There will then ensue like changes in the parental organism and in the germinal cells, and the changes in the parental organs will appear to have been transmitted to the germinal rudiments. Thinking along these lines one might postulate that alcohol, which, in excess, affects the brain of the parent, might involve the brain rudiments in the germinal cell. One may, indeed, parallel this illustration with other organs in the parental organism. Alcohol may cause severe mental disorders and the germinal rudiment may be in-jured in such a way that the offspring may have an abnormally constituted brain, suffering from practically the same character of disease as did the parent, but again some other form of mental disorder might take place involving a different rudiment. Certain organic injuries then may affect the germ plasm while others do not, and these latter, therefore, cannot be transmitted. The effects of an injury and those of many diseases cannot be trans-mitted. If, for instance, the leg of the parent were amputated, the same transmission of the loss of this leg, or arm, stomach, gall bladder, etc., to the offspring could only happen through removal of the portion of the germinal cell out of which the leg or the other organs were destined to develop. Muscular en-largement and development cannot be transmitted, for this would require strengthening of the muscle rudiment in the germ cell by exercise, which is impossible.

When external influences lead to a change in metabolism and when this change leads to adaptation and when the primary con-dition in metabolism is competent to exert an identical influence upon the germ cells, it is possible for the adaptation to be trans-mitted to the offspring; but this is not strictly a form of inherit-ance.[6] Beside alcohol, such factors as lead, mercury, possibly nicotine, carbon, benzol, aniline, iodine, arsenic, x-rays, and certain radioactive substances all may act detrimentally to the germ plasm. But, says Greiv, consequent mutations cannot be racially transmitted, although undoubtedly they favor structural

nd functional unbalance in the child. The word mutation, or hanges within the germ cell, must not, by any chance, be conused with mutilation or injuries to the body, which latter cannot e transmitted to the offspring. The gene transmits its character rue to type and the soma builds up its structural and functional ossibilities. While the soma, or body cells, may be easily modiied without producing hereditary effects, yet, says Detlefsen, the everse may also take place, for the germ cells may be affected irectly by temperature and other changes and by other physical nd chemical agents and produce hereditary effects without first nodifying the soma. The action of these agencies on the germ ells may be first indifferent, second selective, third harmful, and ourth lethal, and may give rise to simple changes in color or in olor-pattern, or again to pronounced irregularities in the growth ate and in normal development.

Tower, in 1906, taking a modest example from the insect world, eported pronounced effects from environmental conditions, such s variations in temperature and humidity, upon the color and olor-pattern of the potato beetle (Leptinotarsa). When the timulus was applied to the eggs or larvae, little or no change was pparent, but if this stimulus was applied to the pupae, unmisakable color changes appeared in the adult, which, however, were not inherited. When the adults were subjected to the same experimental conditions during the so-called sensitive stage of germ cell maturation, the progeny alone were modified and these modifications were inherited. Among animals, cases of germinal modification are also reported. Stockard and Papanicolan, in 1916 and 1918, subjected guinea pigs to alcohol fumes, and while the immediate subjects were not injured, the offspring and later generations showed a record of less fertility, greater mortality, arrested development, defects in the central nervous system and in the eyes. Cole and Bachhuber, in 1914, fed female rabbits and fowls lead acetate, and concluded from their experiments that there was a definite and demonstrable effect upon the progeny as shown in their retarded development. Little and Bagg, in 1904, showed hereditary structural defects in mice and in their descendants exposed to light doses of the x-ray. These included defects of the eye, club foot, extreme brachycephaly, etc. These abnormalities, Detlefsen believed, were true cases of direct germinal response to the x-ray treatment. These examples show an alteration of character and function; but, to our mind, they cannot be considered acquired characters, as the genotype was transmitted as such. Similar conditions can be paralleled in the life of the infant or child.[16]

Every morbid state is characterized by a diminution in functional capacity, at first of individual organs, but ultimately of the whole body, dependent on anatomical changes in the organs induced by injuries, poisons, microorganism, etc. This depression of functional activity cannot be inherited, because the germinal cells do not as yet contain any functioning organs; that is, organs whose functions are capable of being disordered. Depression of this functional activity is not a process per se but is dependent upon the anatomical structure of the organ whose function is affected. If the rudiments of this organ are abnormal in the germ plasm, alterations must assuredly take place in this same organ in the infant, who will then display some morbid phenomenon as did his progenitor, for in this case the same anatomical changes are found in the child as were exhibited by the parent. It is better, then, to speak of the inheritance of anatomical changes rather than of the inheritance of new organs. In fact, there is no inheritance of disease in the rigid sense of the term, for the infant inherits the anatomical changes, not the disease itself. Thus the injurious influence which leads to the morbid change in the parent is itself transmitted to the offspring in the germ and eventually induces a similar change. It is therefore highly probable that living organisms or their toxins, excitors of disease, pass from the parent to the germ plasm, and the results are passed on to the child. When, for illustration, we find the newborn diseased by tuberculosis or other kindred conditions, it will be found most probable that the parental germ has as yet undergone no changes, but merely contains the tuberculosis bacilli whose subsequent development in the child gives rise to tubercular processes and thus renders the infant susceptible to bacillary infection, particularly if the soil is ripe. Pediatricians often note that many fundamentally diseased organs with their marked dysfunctions, as well as many minor malformations, may not seriously impair the vital capacity of the child if the environmental conditions are harmonious to that individual.[6]

SIMILAR FORMS OF DISEASE FROM DIFFERENT CAUSES

Diseases unquestionably may affect all organs and tissues, internal and external. One form of a particular disease may be indisputably due to hereditary factors, while another form in the same environment may assume a less or greater importance. A disease may assume quite different forms in childhood and in adulthood because it is controlled by quite different influences and caused by quite different agencies. Also its prognosis must

be differently foreseen. Diabetes in the young, for instance, is hereditary; while in the adult environmental conditions probably play a greater role in its causation. Certain types of goitre are dependent for their origin mainly on the constitution of the germ plasm; while in older individuals toxic substances or certain forms of infection are responsible. Even certain forms of epilepsy assumed to be of absolute hereditary origin in the young may develop later from an injury. Mental diseases in childhood and in later years follow quite divergent courses and arise from different sources. While some of the most important pathologic mental states are undoubtedly inherited, yet others seemingly suggest, in addition to these changes in the germ plasm, an association with an inherited dysfunction. Most children stand constantly on the border line between disease and health and when the diseased organ becomes healthy or the healthy organ or organs grow diseased the changes are often so subtle that the observer may be unaware of them at the time, for they gain importance only with maturity.

It is impossible to foretell to what extent many hereditary diseases of the body and of the mind might be prevented, or at least brought under control, were we able to provide a suitable physical and mental environment to predisposed children from their earliest years. Therefore in our paucity of exact scientific knowledge, and with the brain and body of the child undergoing physical and psychic evolution, mental tests can be but futile.[7]

FAMILY INHERITANCE

It is a remarkable fact that in a certain group of illnesses with morbid heredity, female members of the family remain free from disease although they transmit to their sons a morbid taint which they, the females, received from their fathers. Changes take place in their germ cells and in their ova, latent characteristics which correspond to disease. It all means that the male members, perhaps themselves not diseased, transmit such morbid conditions, not to their sons, but to their grandsons through their daughters. One sees an arresting example of this in hemophilia, a condition due possibly to a deficient coagulation of the blood. Ribbert mentions a family in Switzerland of 218 members, of whom 37 of 121 males were bleeders while all 97 of the women were exempt. Among this group there was a high infant mortality. In color blindness, or the inability to distinguish colors, as well as the tendency to confuse certain colors, particularly

red and green, 15 males to every female inherit this malady. Another example is night blindness, where subjects see badly in moonlight and twilight. This character is transmitted by direct inheritance and the females are practically exempt. Progressive muscular atrophy springs from dominant inheritance. The females of a family are free from congenital optic atrophy, but transmit it to their sons and, in some cases, to their daughters. The explanation of the transmission of these pathologic tendencies is often far from easy. Many of them may appear alike in males and females and often descend to both sexes, yet affect, in general, only half the children.[6] When, however, a child of a diseased parent or parents remains unaffected, the morbid character is interrupted and the future offspring will be free from the taint. Meggendorfer cites the condition of brachydactylia where one parent is affected. As a rule half the children will show the condition.[17]

DOMINANT AND RECESSIVE QUALITIES IN DISEASE

Applying a ratio between dominants and recessives to inherited characters in children, we find a possibility of 75 per cent of diseased characters to 25 per cent of healthy ones. Hence, when diseased individuals unite with healthy ones in the act of procreation, it may happen that if the disease be dominant in character all the children will be diseased. It must be remembered, though, that these same children have received healthy recessive characters along with the dominant disease rudiments. Therefore, if they marry healthy individuals, the segregation of factors allows a chance for healthy offspring. Again, it is conceivable that a permanent and intimate mingling of the two characters might occur and no process of segregation result.

It is known that disease characters as well as sound characters may be transmitted as dominants or recessives in heredity. Some biologists believe that they can tell from the type of the morbid character the mode of its transmission. Lenz, to illustrate definitely, tabulates many such characters. Von Roch finds that congenital dislocation of the hip, for example, is a recessive character which is observed more often in female than in male transmission. Hare-lip and cleft palate, which also descend through several generations, may be both dominant and recessive. Congenital keratosis with early death is recessive in character, as is amaurotic idiocy. The latter occurs generally in the Jewish race, and when found among Gentiles is probably due to an

admixture of Jewish blood. Even then it is found only in the union of two recessives.[18]

Characters in related individuals are influenced necessarily to a greater or lesser extent by the same ancestral factors, therefore certain family tendencies or strains are continued by inheritance. Recessive characteristics appear very often as diatheses, or potentialities to disease, in those of close relationship, hence it follows that the offspring resulting from a mating of these parents are the recipients of these disease characters in double measure. It is interesting to note that these disease characters are not always inherited "pure," for what is received by the offspring may be similar to, but not identical with the parental manifestation. For example, an asthmatic may transmit a tendency to an exudative diathesis. Also, the same kind of disease character may manifest itself differently in different persons in consequence of dissimilar environmental factors, or through the combining of other hereditary tendencies which are present in a number of different family groups. Often twofold or manifold disease conditions, recessive or dominant, may occur in the same child, such as congenital heart abnormality plus a disorganized nervous system. However, as Weitz points out, the physician may intervene, and through scientific means modify and often cure the existing dysfunction.[19]

Physicians frequently note that some families have a psychologic diathesis, others a gastro-intestinal one, while still others may harbor an osteoporotic diathesis, an inherited tendency to bone brittleness. This appears to be a dominant quality, for it occurs in successive generations. Davenport has discovered that of a total of 150 offspring of parents affected with this bone condition, 83, or 55 per cent, are afflicted.

In some families the bones apparently are broken before birth, in others, some time in early childhood.[20] Club foot, Lord Byron's defect, is seen as a combination of recessive factors in both parents, and appears only in a part of the descendants. Usually from the inbreeding of persons carrying recessive factors for disease characters, we find about one fourth of the offspring showing defects. The Nettleship rule is, once free, always free.[17] Often the potentiality to certain types of disease is found in the recessive characters of past generations. Through the combined activity of similar genes, we can commonly prove disease tendencies among brothers and sisters in many families in different degrees. Among these disease types may be seen different kinds of goitre with their accompanying train of hypo- and hyper-

function of the endocrines. When certain chemicals which are responsible for the coagulation of the blood are either absent or extremely feeble, one finds hemophilia, which is undoubtedly hereditary, although its transmission is not well understood.

Among the most peculiar of these family disease traits, which uncommonly appear as dominants, is seen the failure of the separation of the two bones, the radius and the ulna, which are formed out of the cartilaginous plate that precedes them in development. Such families are characterized by a radio-ulnar synostosis. In other family groups the retina may be developed abnormally and the ability to distinguish colors may be absent. The latter peculiarity is of great interest, in that the gene responsible for it is located in the sex chromosome.[5] The characters of color-blindness and of family optic atrophy are in this sex chromosome group as well.

Also the structure of the ear, without and within, may be altered and sound and pitch be changed or absent. Family dominant and recessive abnormalities are also seen in the gastroenteric tract, as in Merkel's diverticulum, the persistence of the duct leading from the bowel to the vitelline sac, which, under normal circumstances closes at the eighth week of fetal life. Pediatricians sometimes discover atresia of the esophagus, where, in an overwhelming number of cases, there exists a communication with the trachea besides an occlusion of the esophagus. A cleft palate and an esophago-tracheal fistula may exist with an otherwise normal oesophagus and trachea.

An atresia of the pylorus or a congenital stenosis may be seen, while in the remainder of the digestive tract, one may find anomalies of formation and of connective tissue stenosis, and once in a great while, the Hirschsprung type of stenosis. In the small intestine are frequently found obstructions, atresias, and stenoses, the former being in the majority, and including multiple obstructions in the jejunum and ileum; and in the large intestine more types of obstruction are found, as well as inguinal and umbilical hernias. Occasionally in certain families a division of the common bile duct is found, each passage opening into the upper and lower portion of the intestine.

Certain families, moreover, appear to inherit congenital enlargement of the thyroid, abnormalities of the heart's position, mal-development of the respiratory tract, of the eye and ear, bones and joints, of the stomach, and, in fact, of the size, position, and functional capacity of all the organs and tissues of the body. A careful survey of all kinds of irregular body manifestations which are seen in infants and children should convince even the

most skeptical of the impossibility of treating the young along the too narrow paths of standardized medicine.[21]

Many peculiarities and paradoxes baffle the observer. Deaf-mutism may spring either from heredity or from an environmental source in the soma, such as an infection. Certain diseases may appear at one time to be recessive, at another, dominant in character. Under this heading may be found conditions such as hemophilia, diabetes, etc. Again, observes Meggendorfer, certain inherited disease characters, originally dominant, seem to take a milder course if found to have been recessively transmitted.[17] Certain disease tendencies, often disregarded as purely somatic, may take on the form of a diathesis. Certain infectious diseases which appear to run in certain families and to which many of their members are very susceptible, are cases in point. Undoubtedly in such instances the germ plasm of the parents has been in some uncertain way injured.[23]

Deaf-mutism, tetany, at least in part, mental aberration, epilepsy from probable chronic alcoholic ancestry, imbecility, idiocy, all can be traced backward. Metabolic disorders, rheumatism, obesity, diabetes in children, are all transmitted. Neurofibromata, bony tumors and certain others, though uncommon pictures, are potentially transmitted through certain disturbances of the embryo. Eosinophilia, an abnormal behavior of the white blood corpuscles, calcareous degeneration of the arteries, and a tendency to piles may have an hereditary disposition.[6]

Clarence Loeb, in a study of hereditary blindness which was published in 1909, tabulated the results of 304 families suffering from this affliction.[22] Of those families, there were 1,012 children, 58 per cent of which were afflicted; about the percentage, in fact, one would expect when hybrid defectives mate with normal individuals, the defect being dominant in character. A perverted character transmission is seen in the increasing number of families which possess the unfortunate power to transmit to their offspring a tendency to loss of hearing. Obviously what is really transmitted is not actual deafness itself, but some anomaly of the auditory organs or of the nervous system, or the tendency to some disease of which deafness is the result or the symptom.[23] Alexander further emphasizes the hereditary taint of deafness in his enumeration of causes as: first, an hereditary taint of impaired hearing; second, an anomaly of the face, extremities, or trunk; third, a nervous taint; fourth, from hereditary syphilis; and lastly, deafness acquired through accident or sickness which may be considered environmental. True deaf mutism is always congenital and is due to the failure of proper embryonic development

of the cochlear nerve, the spiral ganglion, to Corti's organ, or to atrophy of those parts which are the result of a congenitally defective or arrested development in the area of the capsule of the labyrinth of the middle ear.[24]

The close relationship of many diseased characters is seen in the work of Alexander Graham Bell, who showed, even as far back as 1888, the undoubted correlation between blindness, deafness, and idiocy all affecting certain members of certain families.[23] Bates, too, collected hundreds of cases of definite inheritance characters which showed the transmission of many physical and mental traits as well as defects, some of which were traced back for centuries. Many traits often lie eternally buried, but some bob up now and then as recessives.[25]

While hereditary diseases often do not appear in the offspring of the affected persons, and while whole generations may be skipped so that the children remain healthy, yet the grandchildren may become infected. There appear to be several reasons for this. First, the conjugation of a diseased germinal cell with a healthy one may result in the suppression of a morbid character by the normal so that the infants remain healthy. Another explanation which would indeed seem closer to facts is that all germinal cells of a diseased parent are not necessarily affected, for the injurious influences which gave rise to a change in the germinal cells are not yet in operation. An example of this is chronic alcoholism in the parents. If either parent or both parents did not take to excessive drink until after marriage, the first children would be healthy, the later ones diseased.

However, such conditions have no natural bearing upon the origin of those diseases of earlier generations. The germinal cells as well as the individual within whose body they are found are all derived from the same germinal cell of the parent. But if all germinal cells were affected all the offspring would likewise be affected, which of course does not occur. Logically, some of these cells certainly do remain healthy, but the altered and diseased organ rudiments remain side by side but wholly distinct in the primary germ cells of the child that proceeds from the fertilized ovum.[6] Certain ova or certain spermatozoa are affected while others are exempt, meaning those arising, of course, from the primary cells. In this respect there is no departure from Mendelian inheritance.

MALFORMATIONS

Other manifestations of a morbid inheritance are the malformations, which are usually transmitted to half the children of both sexes, while the children of normal individuals remain, of course, unaffected. Pediatricians often see congenital malformations, such as hare lip, cleft hands, web toes, and absence of sweat glands in the body, all of which may be found in children whose parents are entirely uninvolved, and whose grandparents may have been unaffected also. These malformations may have descended, however, from ancestors well in the past, and are atavistic in character.

Certain affections of the skin, such as tylosis palmaris, an irregular thickening of the skin of the palms of the hands or of the soles of the feet, are hereditary. Also in the same group, may be found albinism, an absence of pigment from the skin more often seen in the deeply colored races. Onychogryphosis is a claw-like formation of the nails of the fingers and toes which, at least in one case, has been observed in brothers, sisters, in a mother and daughter, and in the granddaughter. Pathologic dysfunctions, undoubtedly, psoriasis, and xeroderma pigmentosum are hereditary. Anomalies of the eyes, such as congenital opacity of the cornea, shortsightedness, pigmentary atrophy of the retina, glaucoma, congenital cataract, also come within this category. Many pathologic manifestations of the central nervous system, such as hysteria neurasthenia, word blindness, hereditary ataxia, congenital myotonia, and trophic edema, have a probable hereditary foundation.

HEALTH AND DISEASE

The main responsibility of the pediatrician is to combat disease, establish health, and to keep the infants and children under his charge well and happy. He must recognize ill health, its danger signals, its causation, and its possible prognosis. The phenomena of good health he must also recognize, and when and why the pathologic so often intimately borders on the physiologic. To the well trained and experienced physician the five senses are of great service in the diagnosis and treatment of disease. Disease can be diagnosed in a general way by sight alone, even before resorting to other aids.

In modern times, with a well-equipped laboratory readily at hand and with the aid of sera, vaccines, vitamins, etc., the cure of disease through the time-worn method of simple foods and of

well-balanced metabolism seems, in certain circles, to have been neglected. Such diseases as consumption, pneumonia, tonsillitis, arthritis, the infectious and contagious diseases stand out clearly against the background of minor ailments. But often the approach of tetany, rickets, scurvy, certain forms of eczema, and gastro-intestinal irregularities is insidious, and the minor abnormal conditions of the brain, lungs, kidneys, pancreas, larynx, pharynx, and other organs do not thrust themselves so sharply upon our notice, so that their early stages are often unrecognized.

Such conditions as rickets, scurvy, and tetany, are now known as deficiency diseases, and are all caused by the lack of some essential ingredient of normal nutrition. If unbalanced metabolism is the associate cause in these disturbances, is it not equally a factor in the production of certain types of pneumonia, tuberculosis, and other disease processes, for are these diseases not the results of organic malfunction? In general, also, the deficiency diseases are supposed to arise from the omission of some particular food principle or principles in the child's diet. In particular, owing to the constitutional and conditional etiology of malfunction in each individual child, there may be other and quite different food and medical requisites lacking, rather than the vitamins alone. Thus remedies which suit one child may be absolutely unsuited to another. There is so much in the etiology of disease which, on account of its constitutional and conditional aspects, is at times so difficult to fathom that when groping in a maze of disjointed experiences, seeking a rock upon which to cling, the physician may find that the nearest approach to a refuge lies in balanced metabolism.

The symptomatology of disease and the characteristics of good health in children are but the outcome of natural phenomena and are governed by definite laws or principles. Special study and research in biology, physiology, psychology, metabolism, in foods and their preparation, in economics, sociology, bacteriology, pathology, histology, in heredity, environment, etc., throw new light upon the problems of health and disease in childhood.

Each child is of a different mold, and therefore case histories, so often lauded and published in books and journals, can but show a trend of the conditions, a mean of a particular disease. They cannot assume the responsibility for the pathology or the symptomatology of thousands of cases of similar etiology. The path of disease often affects organs of the child's body other than that in which the disease may have originated. There is in disease a disconnection of that close interrelationship of all the organs and tissues. Therefore, in interpreting and treating nutritional

disease, one must view the organism as a whole and not dissect a part of it away for treatment, for no organ is independent of other organs. Every organ has its own specific function which is susceptible of being influenced by its neighbors. Thus, in health and disease, functions are modified to suit the exigencies of the occasion. To understand how symptoms and reactions are produced, it is necessary to know not only the structures participating, but also the nature of the modification of the function and that of the individual structures. It is important to realize that while one organ or structure is hypofunctioning another, or a series of organs, may be hyperfunctioning, bearing the load of the former and trying to balance the organism as a whole. A series of symptoms in a particular class of cases may appear so foreign to accepted theories that without detailed observation these symptoms may appear to constitute another disease or condition.

Thus there arises a new medical nomenclature and one reads of Jones' diseases, Brown's disease, and Smith's disease. Often a symptom or group of symptoms is recognized and remembered by name alone after the underlying disease is forgotten. In many treatises on the treatment of disease there appears often an accumulation of meaningless words which obscure much information which the author tries to convey. Medicine today suffers, as in the past, not so much from charlatanism and ignorance as from the tenets of primeval cults restricting their members to practice under their archaic doctrines. Such cults thwart progress, freedom of thought, and individual action. The trend, too, of some men to restrict themselves entirely to a certain specialty and to fail to recognize the influences of other parts of the body upon those in which they are directly concerned is a mistaken one. To bring about a more universal nomenclature of all pathologic and histologic phenomena, one which we can all readily understand, it is essential for us to accept the basic principles of life and the study of the biologic cell. Too often, one worker does not understand the language of another. There have come into common use, for example, says Mackenzie, such vague terms as stimulation, inhibition, conduction, contraction, and tone; all obscure terms; for often no one is the wiser for their use. The heart is stimulated, but what are the structures which participate in or bring about this stimulation? In inhibition also, we have no information about the structures involved in producing that slowing to which the name inhibition has been given.

Take, for illustration, pain in an infant or child. The physician in charge must know about the structures which generate

impulses if he is to discover the cause of this pain. Such understanding implies a detailed diagnosis and a mental quickness as to the histologic and pathologic structures involved and of their influences upon the particular cause of this pain. The physician, however, does not know why or how the so-called "pain" impulses differ, if they do differ, from many other impulses.

This brings us back to the important questions, "What is *disease,* and what is a *symptom?*" The definition of *disease* may be summed up in the words, "the reaction of the body to an injurious agent." A symptom is the exhibition of the abnormal or unusual activity of some structure or organ. No organ lives or acts by itself; hence, disease may be termed a dysfunction of an organ or organs and the symptom may be its agent in locating this malfunction. All organs being interrelated, we come to speak of what is known as "reflex action" and of the structures involved as the elements of the "reflex arc." These include, first, those structures which generate and discharge the impulse, second, those structures which convey the impulse, and third, the "effector" organ which responds or reacts to it. Symptoms are due to a modification of the activity of the effector organ; the disturbances causing them may originate in some other element of the reflex arc.

Hence, the symptoms of disease are due to a disturbance of the reflex arc. Such symptoms may appear as, first, an increase in the number of impulses reaching this "effector" organ; second, a decrease in this number; or third, an interference with the generation or conduction of impulses. Moreover, these symptoms may be classified under three different forms:—First, those which are dependent upon the increased activity of an organ; second, those dependent upon decreased activity; and third, those dependent upon the cessation of activity or on the ill-regulated or unregulated activity, thereby giving rise to purposeless or disorderly function. The symptoms exhibited by an organ are very frequently due to a disturbance of those structures which generate or conduct the impulses. For instance, the functional efficiency of the *heart* is known to be dependent on the integrity of the heart muscle. It should be remembered that when an organ is said to be "paralyzed," it can no longer exercise its normal function. What has really happened is that the organ has been deprived of the influence of those impulses which normally regulate its activity. The cells of the organ are still living and are still supplied with nourishment. They are then bound to discharge their function if the nerve path only be given them, for if a paralyzed organ be examined, it will be found to exhibit evidences of its

original activity. If, for example, the organ's normal function is to conduct impulses from a particular generating source, it will still continue to conduct such impulses after the original source has ceased to act. Of course, the new impulses will be of a type different from those ordinarily present.

The effect of these new impulses upon the structures to which they are conveyed will therefore be different from the normal, and the structure will display an abnormal form of activity. Thus, for example, if the paralyzed structure be one which ordinarilly performs the act of contraction or of secretion, it will reveal such defective activities as fibrillation or as loss of secretion. Or again, the ventricles of the heart are influenced by impulses from the sympathetic and vagus nerves. These nerves in the normal heart play on the sino-auricular node, which normally respond with great delicacy to the cells of the body, increasing or decreasing the rate of the heart to meet the ever varied requirements of life. When the influence of the sino-auricular node is lost, the vagus and sympathetic nerves act only on the auriculo-ventricular node. The nature of the beats then differs from the normal, for they are often small and imperfect. Another instance is seen in the phenomena which arise as a consequence of the loss of control by the central nervous system or by other genetic systems in the body, as, for example, that of the bowel. In the case of the central nervous system in an overexcitability of limited areas, impulses are produced which are discharged from some limited part of the nervous system, as seen in the uncontrolled twitchings of the muscles in *chorea* and in the various *tics* of the small muscles of the face.[26]

CONGENITAL DISEASES

It is not hard to understand that the damaged germ plasm of either or both parents may result in a dysfunction or in a series of dysfunctions of the fetus in utero. The organic irregularities may range from minor to major forms, depending on the extent of the damage in the germ plasm. Major forms, which usually cannot be compensated by the mother's ordered metabolism, are passed on, to become mental or physical disturbances, often of great magnitude. Malformations of the body organs and tissues, and dysfunctions manifested in severe cases of mental upsets, insanities, etc., fall within the confines of this group, as do also intensive damage to the rudiments of the organs, the endocrine glands, the liver, the heart, the bones, and likewise the cells which comprise the brain. Should there result a hypo- or hyper-

function of these bodies, an unfavorable prognosis is inevitable. In intermediate degrees of dysfunction the prognosis is more hopeful and minor dysfunctions often fail to materialize. It is a question as to how much influence the mother's balanced metabolism exerts upon the intermediate and upon the minor organic disturbances. There is, however, no question as to the futility of this impression upon the major forms.

An illustration of a minor divergence may be seen in the transmission of the teeth rudiments. Whether the heritage of teeth fundamentals originates in the germ plasm or whether they result wholly from uterine causes leaves much in doubt.

However, as the condition of the mother's blood is dependent on the proper metabolism of her food intake, and as the resulting chemo-physiologic processes within her body are the evidence of a balanced or an unbalanced metabolism, it is essential that her nourishment be well selected, in order to uproot these intermediate and minor forms of dysfunction.[27] Her body needs an abundant supply of all kinds of metabolizable food stuffs, proteins, carbohydrates, fat, starches, sugars, and particularly inorganic salts and vitamins. In the case of the teeth, the addition of inorganic salts of calcium and phosphorus and of the vitamin "D" is of paramount importance. Each fundamental organ of the foetus, through its specific cells, draws from the mother's placenta just the kind of nourishment which is required to ripen it. For this reason, it would seem the intermediate dysfunctions may become minor ones or perhaps disappear under proper nourishment, while the minor forms may be totally obliterated. Under faulty metabolism of the mother the reverse picture takes place and a major dysfunction may become a gross major, the intermediate form taking its place, while the minor irregularity may become the intermediate.[28]

If the father alone, let us say, is to transmit syphilis to the child, the treponema pallidum must be carried to the female ovum by the spermatozoon, and in the fertilization of the ovum and in the growth of the embryo the spirochetes must multiply and carry on the combat within the growing fetus, entirely independent of the influence of the mother, the germinal cell rudiments not being involved. If therefore a disease is carried on in the child and the etiologic factor is demonstrated, that disease must consequently have been transmitted by one or both parents in the germ cells or it must have been acquired from the mother in utero. The mother having a given disease may transmit it through the ovum. The close relationship between the fertilization and the development of the ovum within the uterus makes

the possibility of maternal transmission much greater than that of the paternal.

It is necessary for the student to draw a distinct line between the dysfunctions which develop directly from the germ cells and the diseases which are acquired in utero, for their treatment may be entirely different. It cannot be denied that in almost every disease there is a strong relationship between the past and the present, and body build, weight, and height show potentialities of disease or health. In the vast majority of causes, says Keilty, the etiologic factor of the disease itself, when not an inherited dysfunction, is congenital and acquired by the child in utero. An infected father infects the mother and the mother the fetus. When a congenital disease is present in the fetus and is apparently unmodified by treatment, it is well to inquire if the etiologic factor is present and still active in the parent and if its effects are still taking place; also, if active, has it any influence on the gemules of the germ plasm? [29]

New-born infants are frequently attacked by digestive disturbances which may take the form of diarrhoea or severe attacks of vomiting, even though the mother's milk is to all appearances good. Usually these disturbances are attributed to prenatal conditions. In older infants these attacks of diarrhoea and vomiting are said to arise from external environmental conditions such as improper food, faulty hygiene, lack of open air and body freedom. While many such cases may be truly environmental in type, many others may possibly be traced to a tainted germ plasm which causes a moderate dysfunction but not a true digestive diathesis. That constitutional dysfunction plays a large part, however, in such digestive disturbances, is pointed out by Eliasberg, who found that of 80 breast fed infants suffering from summer enteritis, 70 showed constitutional anomalies of a mild type. In the days of filthy and unhygienic milk handling, which included unclean pails, milkers' dirty hands, etc., constitutionally superior infants and children survived while constitutionally inferior ones did not.

Langstein reports that of all children seen by him at the Augusta-Viktoria-Haus in Charlottenburg over a period of ten years, who died of digestive disturbances, one third showed very marked constitutional dysfunctions.

There is no question in our mind that the great infant mortality of the first few weeks after birth is markedly influenced, not so much by environmental conditions, as by the inheritance of diseased characters, and does not result from purely congenital causes.

In the great susceptibility to infectious disease, to anemias, to certain forms of pneumonias, to hypo- and hyperorganic function, and to many other organic irregularities, one may observe the impress of a tainted inheritance as well as a bad environment, rather than a congenital condition. In a favorable environment, a good constitution in infancy and childhood will create its own immunity against disease.

Whether the fundamental metabolic deficiency diseases of the fetus in intrauterine life have any correlation with a damaged germ plasm of the parent or parents, remains, at the present time, in doubt. There are, however, diseases which originate in utero which are unquestionably due to intrauterine infections implanted by either the mother or father. Congenital disease is, therefore, strongly contrasted with that of hereditary origin.[30] In certain cases malformations are congenital, for they are due to injuries of the fetus within the uterus.[18]

PRENATAL INFECTION

It is often therefore very difficult to differentiate between those diseases which are hereditary and those which are congenital. Malformations and other conditions of the fetus in utero may be due to hereditary causes or are the result of accidents, while other defects may be the indirect result of a faulty nutrition of the mother. It is often hard to understand whether defects are the result of a damaged germ plasm alone or whether they are the products of an altered germ plus the addition of a pathologic condition of the uterus. If the germ plasm is altered, a diseased character is formed, and if the fetus is further burdened with toxins from an infection of the mother or father, death within the uterus may ensue.

The embryo is nourished by the mother through the placenta, and substances in solution pass from the mother's blood into that of the child. Poisons such as alcohol and the toxins from infectious diseases find their entrance, just as do improper food materials which are elaborated from the biologic cell, and which may cause the sickness or death of the fetus. Though we can not imagine microorganisms tenanting the chromosomes we do know that the placenta may harbor bacteria, such as the tubercle bacilli, with the eventual infection of the fetus with tuberculosis. The more virulent the poisoned condition of the mother, the greater will be the involvement of the placenta, and if the unfortunate woman dies at the end of pregnancy or during parturi-

tion it is often possible to demonstrate abundant bacilli in the body of the dead infant. If the fetus has absorbed the bacilli in milder form the infant may linger for days, weeks, or months with tubercular foci within its body.[6] It is not generally known, however, that many diseases, such as anthrax, typhoid, small pox, scarlatina, measles, acute pneumonia, erysipelas, and other infections, may be transmitted to the fetus through the placenta. Intrauterine injuries, infections, and malformations of the fetus may have a decided effect on the subsequent constitution of the infant, affecting its physical and mental development and growth. When of minor degree, many constitutional defects do not stand out conspicuously in infancy; it is only when the organism matures that they are manifested. In later years defects of body and brain are easily recognized.

Meggendorfer asks a pertinent question. Does the change from the normal in a given child rest wholly upon heredity or is it due to environmental external causes? He himself is unable to give the answer, because, as he says, a disease or an abnormal condition of inheritance may be congenital, it may not be necessarily hereditary. He cites, as an example, lues, which he considers congenital and not hereditary. To understand in many cases what is inherited and what is acquired, he finds a hard task, but considers the "twin" method of discerning disease the best judge. Twins of the same fertilized egg, he states, are undeniably alike in hereditary characters. Then as they grow and develop, certain differences stand out as to health and disease which are gained from environmental sources, such differences being acquired particularly if the two lives lie in different environments.[17]

NON-BACTERIAL POISONS

Non-bacterial poisons, arising perhaps from faulty metabolism, may permeate the parental body, and besides affecting the liver or brain, may injure the rudiments of these organs in the germ plasm. Quite commonly the pediatrician finds in offspring morbid phenomena that resemble those seen in the parents, but in this instance there has been no transference of the germ anomaly from the parent to the germ, for morbid conditions acquired by the parents are not transferred to the germ. Morbid states in the germ almost always arise independently of those of the parent; sometimes, though not always, through similar conditions.

While inheritable diseases appearing in the children originate in the germ and not directly in the parent alone, yet the ab-

normal condition of the parent is an intermediary factor in the production of the independent germ lesion. Such conditions are, of course, theoretical in character, but they may occur.[6]

POISONS OF THE GERM PLASM

Often when the physician finds himself confronted with a dysfunction, or with a series of dysfunctions, whose origin is both complicated and obscure, he may consider alcohol or syphilis or even tuberculosis as the underlying cause. These three poisons often have the same morbid influence upon the constitution of children as they have on that of contaminated sufferers. Parents who are affected are incapable of begetting healthy descendants endowed with a vigorous natural immunity against pathogenic microorganisms. Fortunately, however, it is uncommon to find both grandparents or both parents affected, so that one sound ancestor may counterbalance the evil influences of the other.[20]

While it is true that a microbe itself cannot be a part of an organ in inheritance, and while it cannot influence as such the germ plasm or the hereditary genes, undeniably its toxins can. Although syphilis and tuberculosis come within this definition, alcohol does not, since it is non-microbic.[8]

Alcohol. One does not need to be a prohibitionist to realize that alcohol in excess carries with it the stigmata of weakened descendants. The work of both Stockard and Pearl leaves no ground for doubt that alcohol kills or injures many germ cells and that such injured cells may give rise to defective individuals, the deflections from normal persisting through two or three generations. It is the chromatin of these cells which is injured; it is known that both the chromatin and the cytoplasm may be damaged by various unfavorable conditions. Even if the injury is not great, yet the pathologic abnormality may persist through several generations and may cause subsequent defective or abnormal development, not so extreme, however, but that these abnormalities can be balanced through harmonious environmental agencies. But one cannot speak of this type of inheritance as acquired. In Stockard's experiments on guinea pigs the animals were alcoholized to a degree far greater than ever occurs in man, for these little creatures, five years of age, were subjected to this poison for more than four years. Conklin thinks that the use of alcoholic beverages probably never produces such serious effects upon the germ cells in man. Elderton and Pearson made a mathematical contrast study of children approximately nine years of age, born of temperate and of intemperate parents, and con-

cluded that parental alcoholism exerted practically no evil effects on them. This much may be said, however; the more serious the injury to the germ cells, the quicker they die, and it may be that children with alcoholic heritage who survive may have come from the germ cells least injured.

Feeble-mindedness in children is related to alcoholism of past generations and is probably transmitted as a Mendelian recessive. Insanity and feeble-mindedness may often point to syphilis. If a feeble-minded child comes from parents both of whom are congenitally feeble-minded, or who both have a great deal of feeble-mindedness in their ancestry, such a child is a pure recessive and its germ cells have a double charge of the factor for feeble-mindedness. Therefore, when two such people mate, all their offspring may be expected to be feeble-minded, for all eggs and germ cells contain the factor F and when any egg is fertilized the child produced is, of course, an FF individual. As a matter of record, of 144 such matings resulting in 482 infants, 476 of them were feeble-minded, according to Goddard, and the remainder showed peculiar variations although they were not feeble-minded.

It may also be of interest to note that a generation ago the valley of Aosta in northern Italy was swamped with feeble-minded, idiots, and cretins. Sixty per cent of the whole population was affected. Laws were enacted prohibiting marriage of those so affected, with the result that the situation soon clarified itself.

Insanity and brilliancy are often found in the same ancestry and one can predict with certainty that both insanity and brilliancy of mind will appear at some future date.[22] Just how or when this will occur one never knows.

Alcohol exerts grave influences on the reproductive glands, particularly on the spermatozoa-producing cells of the testicle, with the consequent destruction of the seminiferous tubules and their replacement by connective tissue. Von Bunge believed that the incapacity of the daughters of drunkards to properly suckle their infants was due to the effects of alcohol. This statement, however, does not go unchallenged. Agnes Bluhm administered alcohol to rats, yet the young all suckled well. The experiments made by Laitmen on guinea pigs tended to show that the offspring of animals poisoned with alcohol developed imperfectly as compared with the controls and were less resistant to disease. He injected rabbits and guinea pigs with tubercle bacilli, and to some of the experimental animals he gave alcohol in addition to their other food. Of the alcoholized animals a large per-

centage died and their offspring died in greater proportion than did the offspring of unalcoholized animals. It is possible, also, that alcohol may inhibit the formation of antitoxins in the body, with disease and mortality as the result.

Sichel found that, according to statistics of 521 children of drunkards, only 203 were known to be healthy, of 118 no records of any kind were available, and 200 died before or shortly after birth. Of these last, 51 were premature, 20 stillborn, 74 died almost immediately after birth, 21 succumbed to convulsions, and 32 to infections, thereby showing a lowered power of resistance.[6]

Herrmann[31] and others have repeatedly pointed out that certain sickly infants surviving the first few weeks, or even days, fall a prey to disease later; also that survivors at this period fall afoul of organic dysfunction, a diminution of vital capacity, as seen particularly in disease of the brain.

Pediatricians often find that school children of chronic alcoholic parents are deficient in intelligence, and when these children are contrasted with those of sober and unalcoholic parents, the former react more unfavorably in point of character as well as in intelligence. Turning the tables, one must not forget that mental disorders in those parents may have been an incentive to this very alcoholism. While, says Siemens, the idiokinetic influence of alcohol on the germ plasm is often hard to prove, yet evil results, such as peculiar and unusual symptoms, as inferiority, frequently reveal themselves. This inferiority would then, of course, become a heritable quality, a racial character, in fact; since it developed as a result of an alteration in the inheritance pattern of the idiotype, and must from then on appear by inheritance in generation after generation, nor can it be made to disappear again through abstinence from alcohol.[32]

Malformations Due to Alcoholism in Ancestry:—Malformations, especially those of the brain and eyes, may appear in the offspring as a result of alcoholic antecedents; in fact, they may be directly transmitted by an alcoholic mother or father. Peculiar paradoxical instances occur in lower animal life which can be transposed into the sphere of human life, for when the weakest members of a family are weeded out, the survivors often appear exceptionally strong. Indeed, from alcohol and other toxic substances resulting in hereditary deteriorations, there may be brought about specific changes in type, specific interferences which may so affect a certain parental organ that a change in the germ plasm may result and the offspring inherit the same

defects of that parental organ, and of that organ alone, without disturbing the general function of the organs.

Children have been found with all kinds of malformations, some of which are visible and others which are not. They are often caused by changes in environment, rather than by a damaged heredity. The character of the child's organic development responds to all such environmental stimuli and is dependent upon certain factors: first, the nature of the organ involved; second, the stage of development at which the stimulus acts; and third, the character of the stimulus itself. The transmission of hereditary diseases in general, and of those resulting from the effects of alcohol on the germ plasm in particular, cast a shadow upon the populace as a whole; for if they continue to be transmitted in the future as they have been in the past, the number of diseased persons will go on increasing as the population itself increases. If, however, the same relative proportion of the population go on increasing, such pathological conditions tend gradually to die out. Among such diseased individuals the infant mortality rates are high, as the offspring are born with a lowered vitality. Genetics may in time assist in the suppression of morbid transmitted characters which are the result of ancestral alcoholism. More and more self-denying, intelligent human beings are forfeiting future happiness by celibacy; for they realize that they are the victims of alcoholic, diabetic, syphilitic, and mentally disordered antecedents.[6]

Syphilis:—Syphilis as an hereditary misfortune stands in the same category as do alcohol and tuberculosis. Perhaps alcohol and syphilis can be more reasonably imagined as damaging the germ plasm than can tuberculosis. This is also true in regard to the transmission of pathologic defects. Often, admits Rosenthal, such defects are hard to demonstrate and to trace. One feels that the poisonous influence of syphilis upon the germ plasm must be a positive one, for we do know that its toxins exert a marked impression on the rudimentary nervous system.[4] Indeed, it can be demonstrated easily that locomotor ataxia or a general paralysis of syphilitic origin in a parent may affect the rudiments of the nervous system in the germinal cells. Pediatricians often lend an ear to controversies which arise from time to time as to whether the effects of syphilitic toxins upon the germ plasm can be transmitted over one generation. Such lengthened transmissions, however, appear to be a fact.[6]

Sibley says that there can be no doubt that occasionally biologic paradoxes arise which are hard to understand. For example, he

mentions a case of syphilis of the third generation; which brings up an interesting point for discussion, for it suggests a possible background for many obscure cases. Sibley's patient was a man of 55 years, possessed of the highest moral character and on whose word the physician could wholly rely. He was unmarried and had never had coitus. His interesting history reads as follows:—five years previous this man noticed a slight ulceration upon his nose-tip and several small ringed patches on the abdomen and thigh, all disappearing, however, in 1917. Later, some rather deep ulcerations on the right side of the face were observed in front of one moderately involving the lobe of the right ear. Some areas of pigmentation appeared upon the forehead. No adenitis was present and the reflexes appeared to be normal. This patient's parents were first cousins, their fathers being brothers. The paternal grandfather had led a dissipated life, being extremely alcoholic, and died under forty years of age. The patient's own father had died at 87 years of senility, the mother at 75 years of some bowel ailment. Both these parents had enjoyed a very healthy life. The patient's maternal grandfather died at seventy from softening of the brain, and the maternal grandmother died at seventy from senility. The patient was the eldest of four children and was born eighteen months after marriage. One of the other children, jaundiced at birth, died at three years of scarlet fever, his brother is alcoholic, but the sister is very healthy. The individual history of the patient showed typhoid at 21 years and a nervous breakdown 20 years later. It would seem in this case as if the germ plasm conveyed the infection inherited by the father to the ovum of the mother, yet neither parent revealed any symptoms whatsoever during their life time.

In general we may state that when one parent is affected genetically with a disease, let us say, syphilis, it is noticed that 50 percent of the children are usually afflicted. When, again, both parents suffer, 75 to 100 per cent of their children are damaged genetically. One cannot expect a pure strain in heredity as a result of the mating of two affected parents.

Mention has been made repeatedly of the terms dominant and recessive in heredity. Suppose, for illustration, there are two individuals affected with syphilis who carry both dominant and recessive characters for disease and they in turn marry individuals carrying the same factors as recessive. Hereditary defects will be present in the offspring because of the transmission of the dominant syphilitic characters. One may point out also that many pathologic inherited qualities are dominant over less

dominant characters and over normal characters; such for instance as cataract, a spotted skin dominant over a distribution of pigment, webbed fingers over normal separate ones, etc. But certain forms of feeble-mindedness are recessive to normal mentality.[33]

Tuberculosis:—No inherited dysfunction, taint, potentiality, or trait concerned with disease has acquired more importance in the layman's mind than has been aroused by the question of the inheritance of tuberculosis. In the clinic and consulting room this question is probably the one most often asked.

It has been by no means an uncommon experience during the last decade to read in newspapers and medical journals and to listen at health associations and kindred meetings to many references concerning the inroads of tuberculosis and its mortality rate among the young and helpless. Statistics do not lie though they do sadden. Many tragedies have been witnessed by the writer, for, of course, disasters from this dread disease occur much more often among the young than among those in later life. The time of greatest discouragement is during the first two years of the child's life; a period when the disease if present assumes an acute and rapid course, for the resistance of the young child to it is very poor. In the adult type the host has the power within himself to overcome the infection, but the infant is not so endowed.[34]

Tuberculosis is a gigantic economic waste to government and to individual. It lowers physical vigor and mental efficiency and it reduces the power of reproduction given the germ plasm, an important role in its transference to the soma. Tuberculosis, however, cannot be transmitted, for its bacilli cannot find lodgment per se in the transmittable factors of the germ plasm.

The male may have general tuberculosis, or even a focal tuberculosis of the testicle, and the semen may convey the bacillus, as a result of which uterine tuberculosis may develop. Both embryo and fetus may be influenced by the endometritis which follows, but this, of course, is not an hereditary transmission. Tuberculosis is not likely to be transmitted by the female ovum because of the rare infection of the ovary. It will develop, however, in the fetus, and is acquired from a focal uterine or tubal tuberculosis, only by way of the blood stream. When the mother infects the offspring through her milk or through the blood stream, the infant usually dies of a lowered body resistance and not from the disease lesions primarily. Keilty cited a case of a tuberculous mother who gave birth to an apparently healthy child. Three weeks later the mother died and an examination

of sputum and blood showed tuberculosis, as had the placenta blood at the time of delivery. Shortly afterward the child died and tubercle bacilli were found in the heart blood although no lesions were found in the body.

It is, we believe, an open question at all times as to whether the offspring from a tuberculous parent will be susceptible or immune to tuberculosis. To date we have not found the answer. A tuberculous mother is obviously in a poor state of nutrition and the resistant powers of the infant will in consequence be very much impaired. When a constant and powerful tubercular invasion takes place, there can be no immunity strong enough to overcome the disease once the enemy has taken firm hold.[29]

While the tubercular bacilli are actual producers of the disease, there are undoubtedly variations in the types of the disease as well as in the racial strains of the infected children. It is, we believe, these differences in resistive power, possibly inherent in the cells, which permit one infant to succumb to a relatively light infection, while another, attacked by a much more virulent form, is able to withstand the encounter.

Our experience strengthens the conviction that one should determine, if possible, the dominant and recessive characters of parental transmission of disease before prognosticating a healthful future for the child. The strength or weakness of the constitutionally inherited characteristics of the body cells undoubtedly determines to a large extent the degree of implantation and the rapidity with which the disease spreads. The dominance of inherited characters, whether normal or perverted, which depend on maturity and environment for their motivations may be expected to have considerable influence in either checking or stimulating the conditions.[34]

In the future, heredity and immunity must be worked out along lines of character transmission and specific environment for the individual child, as well as for the particular form of disease presented. It might be suggested in passing, that syphilis, pneumonia, meningitis, and other contagious diseases could well be included in this group. Keilty believes that diseases which tend to produce antibodies which reside in the blood serum of the parent cannot help much in the transmission of a natural immunity. These bodies do, however, control the transmission and the development of a disease in the fetus by their action upon the mother before and during gestation. Those diseases which produce immune bodies as a part of the fixed cells may pass on, neo-Lamarckians believe. That means that in the gemmules (those little detached buds of a parent cell which form a new

generation) of the germ cells, certain characteristics may eventually build up a strong immunity. There seems to be no doubt in the minds of many that in tuberculosis, syphilis, typhoid fever, and rheumatic infections a more or less permanent immunity can be built up. In some diseases, such as pneumonia, meningitis, and streptococcus infections, immunity, if possible at all, is at best only of short duration.[29]

Probably then, tuberculosis may be considered one of the great menaces to health in childhood. Many pediatricians look upon it as a post-natal infection on a prearranged soil. Yet there can be no doubt that in a few cases uterine contamination has taken place, its victims usually dying within the first year.[4] Many have wondered if there were in reality such a thing as a status tuberculosis. Does phthisis follow directly from a tubercular gland infection, or does it not rather spring indirectly from the lowering of the body resistance, as seen in rickets, malnutrition, scurvy, and other metabolic derangements? For years heredity has been considered as playing an important role in the causation and propagation of tuberculosis.[29] This disease takes peculiar courses and devious ways in different individuals and even in different families. In experiments on guinea pigs, it has been found that tuberculosis follows a different course in different families, these differences remaining constant in successive generations. Undoubtedly a large number of children become insidiously infected with tuberculosis some time in their lives, the disease usually running an extremely mild course.[7] In such cases the pediatrician rarely distinguishes it from other symptomatic conditions; yet he often observes that flat-chested, anemic, pasty-complexioned children do frequently become tuberculous and that they probably carry within them potentialities of this disease. Indeed, the clinician may note certain symptoms in the child's predisposition to this disease, for it is associated in many cases with general bodily weakness, with all its attendant ills. The immune child, on the other hand, is vigorous and his body is endowed with great functional capacity.[6] Nutrition and environment play important roles in its activity, inactivity, and decline.[7]

Ribbert seems less certain than do others regarding the poisonous effects of tuberculosis on the germ plasm. He finds that the disease rarely invades the germ cells, although he admits it may be possible; for there is a possibility of germinal infection, in that the man first infects the woman and she, in turn, infects the developing child. In cases of peritoneal tuberculosis in women, the bacilli may invade the ovum, but, generally speaking, when a woman is desperately ill, coitus and a resulting fer-

tilization do not occur. In the case of the male reproductive glands, even though they are actually affected and contain a large number of bacilli, the danger of transmission is slight, since the disease inhibits the formation of and evacuation of semen."

In a long series of observations, necropsies, microscopic examinations, and inoculations, Debre and Le Long would have us believe that no tubercular contamination is possible by way of the placenta, nor that there is such a thing as an inheritance of a tubercular soil. It must be said, however, in justice to our own opinion, that these conclusions are based on impressions rather than on facts.[35]

Indeed, Pearson has shown that in tuberculosis, not the disease but the diathesis is inherited, not the seed but the soil. The death rate among infants and children, he believes, is largely selective and, therefore, a higher infantile death rate coming at a later period might imply a survival of a stronger and more enduring stock.[36]

Tobacco:—We digress at this point, but without apology, to discuss the practice of smoking among women. Within the past decade, the tobacco habit among women of America has become almost universal and has, it would seem, come to stay. However, women of other countries have long used the weed. Mothers from all classes question the physician as to the evils of tobacco, and, more recently, expectant mothers have raised the same question.

Among the poisonous conditions transmitted to the child in utero, the effects of tobacco, particularly of cigarette smoking, in expectant mothers have been especially emphasized. This habit among the upper and better educated classes has, within a short period, involved also those in poorer circumstances. In spite of ragings from the pulpit, press, and reformers, the sale of tobacco to women is increasing steadily. From clinical experience and from scientific data, there appears to be no proof that tobacco used in moderation by the expectant mother poisons the unborn child. Many dramatic opponents insist that nicotine in the blood of the mother reaches and poisons the fetus. They accuse the tobacco monopolies of profiteering in the flesh and blood of the unborn generation. However, nicotine, a very volatile substance, is destroyed in the burning of the tobacco and rarely if ever passes to the body of the smoker.

Is it true, as Chauncey L. Barber has asserted, that 60 per cent of all infants born to cigarette-smoking mothers die before they reach the age of two years? Such findings, in the light of the

writer's own experience and in that of many scientific men generally, would seem to be grossly exaggerated.

Pediatricians find that the use of tobacco produces only a mild deviation from normal in young mothers. It is quite true that young women often consider body maladjustments as due to cigarette smoking. In these cases, however, the physician usually finds organic dysfunction of one sort or another to account for the symptoms. In young women, particularly in their first pregnancy, unnecessary fear of an evil outcome from smoking often unbalances their whole organism and even results in minor aberrations of the mind. There is no doubt that with the increase of scientific knowledge in the care and treatment of expectant mothers and with the increasing research work in biological chemistry and nutrition, infant mortality has, to a great extent, lost its formidable aspect, in spite of increased tobacco smoking.

The writer has lived in his youth in many countries where smoking among women was almost universal, yet children were born strong and sturdy, and the practice was considered the harmless satisfaction of an acquired appetite. Today in Spain, in Burma, and in Turkey, expectant mothers are smoking and have smoked for generations.

As to the influence of tobacco on the germ plasm in eventually producing a diseased character inheritance, we know nothing. In spite of the fact that Doctor A. J. Kress declared at a meeting of the Chicago Medical Society that, "nicotine exerts a blighting influence on the germ plasm," and that a child born to a smoking mother has a tendency toward degeneracy, apparently neither pediatric nor obstetric literature contains any authorized scientific statements on the subject.

DEFICIENCY DISEASE

MICROORGANISMS

Even though we are convinced that a large number of the common somatic diseases of childhood are concerned in some way with an inherited organic dysfunction, we realize that the most perfect organism ever transmitted can be conquered eventually by a titanic assault of environmental enemies. This dysfunction of body organs, individually or collectively, throws their entire correlated mechanism off balance and there ensues a lowering of what is termed vitality. Climatic changes alone may be responsible for this depressed state of vitality, a fact readily discernible when the change is accompanied by extreme

heat and humidity. The organs then become a receptive field for the implantation of microorganisms or for the devitalizing actions of poisons generated either within or outside the body.

There are three ways in which these microorganisms can harm children. First, they may grow and multiply in food, thereby creating poisons. Second, they may cause excessive putrefaction of the intestinal contents with marked ill effects to the body. Third, they may grow on or within the body itself, poisoning it directly. To these forms of poisoning are given generalized names, one of which is food poisoning. An example is seen in ergot poisoning from a fungus growth on rye. When this unwholesome rye is ground into flour and made into bread an entire community may suffer. The decomposition of protein foods by putrefactive bacteria in the presence of insufficient oxygen establishes ptomaine poisoning. Botulism, another form of poisoning, is caused by microorganisms whose growth within certain foods produces destructive spores. These spores are destroyed at the boiling point of water, and also in the heat process of canning. There are many organisms whose growth in the intestines is accompanied by the production of poisonous material which is absorbed from them. Especially in older children there are sometimes found long periods of constipation during which the production and absorption of these toxins goes on until autointoxication results.

The parasitic organisms must establish a relationship with the host-organisms, or they perish; for bacteria cannot manufacture their own foods. The microorganism, after it has become established among the tissues, does not always find conditions favorable to its development; for certain mechanisms of the body may oppose the active multiplication of the invader. Thus, in many instances the body wages a successful battle against the enemy, effecting its complete destruction. The protection against infection is called "defense" or "resistance" and is allied to immunity. Without the necessary resistance on the part of the body, the unchecked microorganisms pour their toxins into the system and disease is the result. If, on the other hand, the defensive forces are able to counteract the poisons generated by the disease organisms, recovery and health are assured. All too often the body resistance is at low ebb and the microorganism exceptionally virulent, when death may claim a victory.

The child's body has two distinct means of resistance. The first is the aid supplied by the white blood corpuscles in the circulatory system. The second, an immunity reaction, is accomplished by a chemical action against the poison-bearing

organisms. One speaks of a transmitted immunity, as seen in the defense of the suckling against contagious diseases, particularly when the mother is constitutionally sound and healthy.

Insects transmit disease. In a few instances one finds diseases actually produced by them. Certain flies in their larva or young stages may occasionally infest the child's body and destroy parts of the cell structure. While these may not actually interfere with proper body function they are nevertheless a direct cause of disease. For the most part, however, the diseases for which insect life is responsible are produced by bacteria and unicellular animals. The insect may serve merely as a carrier, since it is quite possible for these bacterial forms to attach themselves to the outside of an insect. Then, too, disease-producing parasites may actually live within the body of an insect and there undergo certain developmental stages or changes before being transmitted to some other organism. In this way flies carry typhoid, sleeping sickness, etc., and in all probability are the real culprits in isolated cases where the intermediary carrier has not been definitely identified. Disease may be spread readily over large areas, for flights of ten miles on the part of flies have been definitely recorded. It has been determined also that any of sixty kinds of organisms may be attached to their bodies. In this list may be mentioned scarlet fever and the familiar but now rare disease, leprosy.

The eggs of several species of parasitic worms which inhabit the bodies of children are transported by the house fly. These forms, which are variously termed eggs, germs, or organisms, and which accompany the fly on its travels, are apt to be left by their temporary host as it walks about over uncovered foods, dishes, and cooking utensils, or, for that matter, the child itself may be the direct recipient of the fly's unwholesome burden.

The mosquito is associated with malaria and yellow fever. The flea is associated with the plague, while lice, cockroaches, and bed bugs are equally able carriers of disease germs. In time of war, typhus and trench fever are carried by lice; in peace time bed bugs and cockroaches contribute their share to the quota of infantile paralysis, tuberculosis, and typhoid, so ably distributed by the house fly as well. Upon the mite is placed the responsibility for the itch, scab, and mange, although these latter, of course, rarely attack children. In warm climates, particularly in South America, ticks are prevalent, ferocious little parasites which pierce the victim's skin and gorge themselves on blood. The terrible ibbi of the Bolivian jungles is another scourge.[37]

In general it may be said that the physician has a greater interest in the acute diseases of the body than in the many forms of gross dysfunction transmitted by a damaged germ plasm. Sometimes after a diagnosis he attempts to improve an existing condition through surgery, psychiatry, or medicine. Of late, however, more and more attention is being given to the place of the cell in disease rather than to the organ or tissue which is constructed from the particular type of cell involved.

Experienced physicians are giving serious consideration to such cell activities as mitosis and rejuvenescence in repair, and to metabolism rather than to the changes in the tissue structure directly, and to the physiochemical activities in the nucleus or cytoblastema rather than to the reaction of tissues or to the alteration of functioning organs. The pediatrician of the future undoubtedly will be taught to diagnose the physiochemical or electrical changes in cells under disease conditions, and with this knowledge he will be able to attack disease from a different standpoint. Comparatively few nutritional diseases are purely soma-born. Most of them are linked either with germ plasm or prenatal activities.

Factors contributing to the lowering of the child's vitality are numerous and varied. A prominent one is food which is wrongly selected, improperly prepared, and even impure from a bacterial standpoint. Then, too, weather conditions and temperatures with their sudden variations are a pertinent consideration. Under these and similar circumstances it is small wonder that the bacilli find a fertile soil and the diseases caused by them may be considered somatic in character. A child in apparent constitutional health might readily succumb to long immersion, to the inhalation of poisonous gases, or to the ingestion of certain substances.

By far, however, the most interesting of all somatic disturbances are those which custom has decreed to call "deficiency diseases." Like the rise and fall of the stock market, like the ebb and flow of the tide, like dress reform and modern behaviorism, we have our changes and fashions, our fads and fancies in disease. "Deficiency diseases," "vitamins," and "specific food principles" are words now at flood. Custom has limited the terms to a certain number of substances only, but we feel courageously inclined to prophesy many more which are as yet undiscovered.[27]

GENERAL DISORDERS RESULTING FROM DEFICIENCY FOODS

Had we vision much greater than that of the sage, or had we ocular penetration greater than that obtainable from the beams of the x-ray, we might be able to see the internal pathologic changes due to vitamin deprivation in our little patients. In our autopsy experiences, we have never been able to find an accepted form which ran true to a complete hypothetical type. Among the variations are lesions, mild, moderate, and severe. In the following paragraphs we present a composite picture of these disorders;

1. Congestive, necrotic, and inflammatory changes in the mucous membranes, sometimes involving the entire tract and sometimes limited to definite areas.
2. Degenerative changes in the neuromuscular mechanism of the tract, tending to dilatation of the stomach, the ballooning of areas in the small and large bowels, and intussusception.
3. Degenerative changes in the secretory rudiments of the gastro-intestinal tract, of the gastric and intestinal glands. These changes, as can be readily understood, are such as must cause grave derangements of the digestion and of the process of assimilation.
4. Toxic absorption from the diseased bowel as evidenced by the changes in the mesenteric glands.
5. The impairment of the protective resources of the gastro-intestinal mucosa against infecting agents, due to hemorrhagic infiltration, to atrophy of the lymphoid cells, and to the imperfect production of the gastro-intestinal juices. This impairment results not only in the infecting of the mucous membrane itself but the passage into the blood stream of microorganisms from the bowel.
6. It is to be emphasized that the pathologic changes found in the gastro-intestinal tract are more marked in some children than in others, and that while all of them may occur in the same subject, it is usual to find considerable variation in the incidence of particular lesions in different individuals.[38]

CONDITIONS CONTRIBUTING TO DEFICIENCY DISEASES

Infections, especially those in which food deficiencies are an influential factor, are associated very frequently with a trio of

congenial allies whose presence contributes to the onset an characteristics of pathologic symptoms. These three well-know conditions are improper hygiene, overcrowding, and insufficier oxygen. Taken separately or together, they will diminish th functional capacity of cells, impair protective measures agains infecting agents, and at the same time aid in the multiplicatio of these very agents. Unfortunately, laboratory experiments ar rarely seen by the pediatrician, and the actual biologic reaction are so great in number and so complicated that they are rarel observed or understood by him. To really approximate existin conditions, laboratory experiments would have to include th factors directly traceable to badly congested living conditions.

As far as we know, an infection or debilitating agent whic further reduces the efficiency of the cells and especially the ef ficiency of the endocrine regulators of metabolism may be determining factor in the production of any form of deficienc disease.[38]

EFFECTS OF VITAMIN DEFICIENCY

There exists a group of maladies in which there is a deficienc of certain substances variously called accessory food factors growth determinants, food hormones, exogenous hormones, bu more generally, vitamins. Almost never is the child's food com pletely devoid of any one vitamin, but it may prove to be par tially deficient in one or more of these necessary substances Even more frequently this partial vitamin deficiency is associate with an accompanying deficiency in needed proteins and in organic salts, together with a diet over-rich in carbohydrates. Fo instance, a diet deficient in the vitamins and too rich in starcl leads to the depression of digestive and of gastro-intestinal func tion. If, in conjunction with this condition, the child's organ are exposed to the action of pathogenic microorganisms, th existing functional depressive state may easily become accentu ated or fixed by the organic changes which are due to the patho logic agent. Furthermore, under conditions of food deficiency the presence in the bowel of such agents may determine th character of the morbid states initiated by the food deficiency and even impart to them endemic or epidemic characters. Con spicuous among the deficiency diseases are goitre due to lack o iodine, chlorosis due to lack of iron, beri-beri due to lack o vitamin B, scurvy due to lack of vitamin C, and pellagra du to the lack of a protein of high biologic value.[38]

The causation of disease resulting from faulty food ingestio

is compounded of the several effects of the varying degrees of food deficiency on the one hand and the faulty selection of the food on the other. Nor is this all, for pathologic organisms present in the body during the period of its subjection to the faulty food contribute their share. Many infantile diarrhoeas and certain types of tuberculosis require consideration from the point of view of the pathologic agents already existent in the body, as well as from the standpoint of the pathogenic organisms which bring about the condition.

Not only laymen, but some physicians also, have a tendency to place undue emphasis on the vitamins themselves in relation to the morbid conditions brought about by food deficiency. Too little stress is placed upon differences in age, sex, environment, fatigue, individual idiosyncrasy, metabolic rate, etc. Seasonal changes, with their extremes of heat and cold, must not be overlooked. Home surroundings, if they include the well-known effects of overcrowding and the perils of bad sanitation, create situations which foster disease. The various susceptibilities of "sensitized" children must be considered, and these include the different reactions of the various organs in one individual and the reactions of the same organs in different individuals. Owing to this individualistic characterization of all children, it must be expected that wide variations in the incidence, the time of onset, and the character of symptoms will occur in children in whom the dietetic fault has been to all appearances the same.

Whether these morbid changes in the child are the result of a deficiency of one or of several vitamins, they are all amenable to the same treatment; namely, the addition of the necessary accessory food factors in a well ordered dietary of good biologic value and one rich in vitamins of every class. It is inadvisable to speak of an anti-neuritic, an anti-rachitic, or an anti-beri-beri vitamin, for, while focusing attention directly on one disease syndrome, all others are apt to be ignored. The effects on the nervous system of the older child of a dietary lacking in vitamins and containing too much starch have been emphasized so extensively that equally important factors have been quite excluded. Symptoms brought about by other means may be less prominent but are just as deserving of consideration. Eventually deficient and ill-balanced food rations will produce nervous symptoms, but these latter will have been long since preceded by a multiplicity of familiar symptoms, such as loss of appetite, impaired digestion, diarrhoea, colitis, unhealthy skin, low temperature, slow respiration, a possible cardic-vascular depression, progressive simple anemia, asthenia, etc. In many cases children

are the victims of disease syndromes which remain unrecognize

It is often stated that vitamins are so widely distributed i food stuffs that no community need lack them. Allowing th this statement is to a great extent true, it may be the peop themselves who are at fault for not knowing or providing then People are influenced often by ancient dietary customs, shackle to obsolete methods not only in the preparation of food but als in the selection of it. One cannot stress too strongly the child need of the various vitamins, for in their assimilation lies partial protection against all nutritional diseases. To impro erly process or cook vegetables and other foods is to risk robbin them either partially or completely of their essential nutriti elements.

On first thought, a mention of the great stock market collaps of 1929 would seem to be entirely irrelevant in a discussion c food values and deficiencies. However, dwindling incomes hav been a very real factor in this connection. The best grades c milk are no longer available to many, margarines have taken th place of butter, fruits and vegetables not quite so good hav replaced the first grade products. All along the line, in fac cheaper substitutes have become necessary. In many cases, th purchase and preparation of food have fallen into less comp tent hands.

Infants fed on many of the proprietary foods in common us may still come within the meaning of deficiency-fed, unless th diet be augmented by other foods. Much brilliant advertisin that receives wide attention tells in glowing terms of the meri of this or that breakfast food as essential to the growth of youn children, whereas an analysis shows it to be sadly deficient i protein, vitamin, and in other nutrient content. It is true, n doubt, that this same food may contain large quantities of starc and sugar, but unfortunately as the carbohydrates increase th vitamin content seems to decrease. Even today, there are thos who believe that quantity regardless of quality is all that matte in choosing food.

We are all familiar with the typical spoiled child, harasse and throttled, deprived of play and freedom, cross and peevis pale and pasty of complexion, with unnatural appetite, sluggis bowels, mucus laden stools, and possibly suffering from enuresi Is it any wonder that this miserable little creature demanc quantities of candy and rich pastries in an effort to escape th weight of incomprehensible forces that are fast becoming mo and more intolerable? An early victim of digestive dysfunctio

and perverted metabolism, he goes through youth high-strung, thin-skinned, excessively nervous, selfish, and generally anti-social, only to reach manhood with endocrine and digestive dysfunctions that make any sort of normal, healthy existence impossible. The animal is guided by instinct in regard to the selection of suitable foods, but the child should be watched and guided with the utmost care and wisdom, for if not he will take only such food as pleases his taste.[38]

Strangely enough, pigeons and fowl are susceptible to lack of vitamin B. Guinea pigs readily show the effect of a deficiency of vitamin C, and rats of vitamin A, and to a less extent, vitamin C. In the same human species different strains often present divergent susceptibilities. A diet which may cause scurvy in some African negroes causes beri-beri in others. A Chinese coolie may develop beri-beri while a European working under practically the same conditions develops sprue. One person may have beri-beri, another gastro-intestinal disturbances. "Nutritional phenomena, let it be said, are basal in character, while differing in detail, they are fundamentally the same in all animals." (Hopkins) These phenomena may have their origin in the several types of dysfunction which are distinctive of certain races and species. In our experience, age seems to be a factor of importance in determining the onset of the symptoms of food deficiencies, for growing animals appear to be more sensitive to the effects of a limited diet than do the mature. It would appear that they require more of certain vitamins for the acceleration of the chemical processes requisite for growth. The concentration of vitamin B in the seeds of plants and in the eggs of animals points conclusively in the same direction. Mellanby found that a dietary which would produce rickets in young puppies would not do so in those over five months of age. Drummond discovered that the length of time that the rat can maintain itself on a diet deficient in vitamin B without suffering serious loss of body weight is directly proportional to the age at which the restriction is imposed. Mellanby has noted that the onset of experimental rickets occurs considerably earlier in rapidly growing than in slow-growing puppies.[40]

EFFECTS OF FAULTY FOODS ON THE ENDOCRINE GLANDS

Of late, scientists have directed our attention specifically to the endocrine glands in their relation to the growth, develop-

ment, personality, and well being of the child. It may be of interest, therefore, to touch upon the effects of food nutrient deprivation on the endocrines.

A series of experiments was performed on tadpoles eleven days old, fifty being used for each test. One set of these experiments was for the purpose of studying the effects of fats:—butter, oleic acid, and cod liver oil. In the first experiment fat was added to the food while the control animals were given the same food without fat. In the second, fat was given while the controls were given no fat but an added five tenths milligram of iodine. In the third, fat was given with the addition of one milligram of iodine per gram of food mixture while the controls received the same mixture of food and iodine but without fat. It was found:—(a) that an excess of several fats in the food of the tadpoles caused a remarkable retardation in their rate of growth; (b) iodine in the amounts of five tenths milligram per gram of food mixture tended to prevent this retardation of growth induced by the butter and oleic acid but was not effective in the case of the cod liver oil; (c) while the compensating action of the iodine varied with the several fats, it was almost as complete in the case of the oleic acid as in the case of butter; (d) the retardation of growth induced by the cod liver oil was further accentuated by the iodine; (e) the retardation of growth induced by the fats was associated with a delayed development of the thyroid gland.

Iodine, however, compensated for the retardation of thyroid development induced by butter and oleic acid, but did not compensate for that induced by cod liver oil. From these results and from others of a similar nature, the general conclusion may be drawn that in so far as butter and oleic acid are concerned an intake of iodine approximately proportional to the intake of these fats in the food is requisite for the maintenance of normal metabolism and for the normal functional capacity of the thyroid gland. Thus, here is a reverse effect of butter and cod liver oil and it indicates an important relationship between thyroid function and the metabolism of iodine and fats. Free oleic acid favors thyroid hyperplasia and cod liver oil acts against it. The indications are that there exists a fat-thyroid iodine balance and this balance may be disturbed either by an intake of iodine insufficient for the needs of the body in the particular circumstances in which it finds itself or else by the presence in the digestive tract of an excess of fat, but more especially of an excess of free unsaturated oleic acid.

Small goiters often seen in children before puberty and usually

in girls may arise either from actual or relative iodine deficiency. This would indicate an example of a deprivation caused by an insufficient supply of any one essential element of food. The iodine increases in consequence of, or is favored in its rise by the larger amounts of another essential nutrient of the food or fat.[41]

The endocrine glands influence the organs of the digestive system through the hormones and through the sympathetic nervous system. Food deficiencies derange both the normal production of hormones and the functional adequacy of the sympathetic nervous system. Consequently the digestive organs are deprived of the full advantage of the efficient regulation and correlation which they would normally derive from healthy endocrine action. The involvement of the duodenum and the pancreas in consequence of vitamin deprivation may lead to abnormal secretion.

The thyroid gland promotes the flow of the gastro-intestinal juices. It is of course well known that hypothyroidism may lead to hypoacidity and to an impaired secretion of the gastro-intestinal juices. In both the stomach and duodenum such lesions are produced as petechial hemorrhages, superficial hemorrhagic erosions, and acute ulceration with diffuse inflammation. It seems logical to conclude that this thyroid insufficiency may in some cases cause appendicitis. The adrenals also may be specifically affected by an insufficiency which is caused by profound digestive and gastro-intestinal disturbances, such as the imperfect secretion of gastric juice, gastric ulcers, and the derangement of the glycogenolytic process. Failure of the inhibitory action exercised by epinephrin over the muscles of the stomach and intestines may cause vomiting and the dilatation of various parts of the gastro-intestinal tract.

Since the question of food deficiency and its results is a general one, any consideration of the matter in connection with the endocrine system is equally general from the standpoint of its effects on the glands, since, owing to the close correlation and coordination in the glandular system, each gland and the functions and organs influenced are either directly or indirectly concerned. Consider the diagnostic importance of any agency which is capable directly or indirectly of deranging the functional performance of the thyroid gland, which is to the human body what the draught is to the fire. Moreover there are the parathyroids, which control the metabolism of calcium and the efficient calcification of bone and teeth. One is reminded also of the adrenal medulla, whose hormone is concerned in the

maintenance of vascular tone and in the excitation of the sympathetic nerve terminals throughout the body. Then there is the adrenal cortex with its intimate relation to the lipoid metabolism and to the development of sex organs. Of great importance is the pituitary body, which is concerned with skeletal development, with the acceleration of physical and mental growth, and with the excretory function of the convoluted tubules of the kidney. It has been shown comparatively recently that a hormone is produced in the posterior lobe of the pituitary body which is capable of influencing intestinal muscular control. The reproductive organs too have a profound effect on physical development and on psychic function. It is true that all hormones stimulate metabolism. We find the adrenals and the thyroid glands on opposite sides, for, while the former tend to undergo enlargement under food deficiencies, the latter may atrophy. Very extraordinary, however, is the fact that with foods rich in proteins and fats, plus a plentiful supply of vitamins, the thyroid enlarges and the adrenals diminish in size.

It means simply that in the former case the body needs more adrenal and less thyroid hormone, while in the latter case it needs more thyroid and less adrenal. Deficiency derangements in diabetes always means endocrine insufficiency. The thymus, for example, often undergoes extreme atrophy when deprived of vitamin B. This same condition prevails even if the diet is fairly well balanced as to proteins, fats, and carbohydrates, but lacks vitamin B. When vitamins are lacking in the food intake, the spleen atrophies and its storehouse of vitamins becomes exhausted. A progressive degeneration of the nerve cells, especially in the groups of cells in the optic lobe, may arise. The brain suffers a moderate loss of weight in extreme cases, and may suffer as well from hyperanemia, anemia, and softening in older subjects. The human brain varies greatly in weight and is dependent on the composition of the food intake. When necessary food is withheld, the results may be headaches, mental confusion, impairment of memory, and lack of concentration. Mercier found that these symptoms resulted from diets rich in fats and carbohydrates but with a deficiency of meat.[38]

FOOD DEFICIENCY AND THE GASTRO-INTESTINAL TRACT

The health of the gastro-intestinal tract is obviously dependent upon a well chosen food supply. This means an adequate supply of vitamins, among which B and C are especially im-

portant. The absence of vitamin B, even when vitamin A is present, is capable of producing pathologic changes in the intestinal tract which will bring about colitis. In fact, a state of ill health of the gastro-intestinal tract may logically be a prescorbutic manifestation of disease because of insufficient vitamin intake, especially when associated with an excess of starch or of fat or of both in the food. This disorder of the gastro-intestinal tract is enhanced when the deficient food is at the same time ill-balanced.[38]

The gastro-intestinal tract then furnishes the pediatrician with many intricate nutritional disease problems. It is for this reason that a clinical picture of the effects of food deficiency upon it is here presented.

In an experiment with monkeys on a diet of autoclaved rice, the abdomen was found to be bulging and tympanitic, its walls thinned and completely devoid of fat. The inguinal glands were enlarged and the omentum existed only as a thin transparent membrane from which all traces of fat had disappeared. The mesentery was exceedingly thinned but its vessels were rarely engorged with blood. The mesenteric glands, especially those of the colonic mesentery, were much enlarged. The stomach also was greatly dilated and its walls, as well as those of the small intestines, were thinned to a great degree, the latter either in certain areas or throughout the entire tract. In the small bowel, usually in the ileum, there was found a ballooning of moderate severity. In the small intestine, while intussusception occurred occasionally, probably the most outstanding feature was that of congestion, showing small ecchymoses widely distributed under the serous coat, sometimes limited to the duodenum or to the lower end of the ileum, at other times involving the whole bowel. Externally the large intestine showed evidence primarily of congestion and subperitoneal ecchymoses, secondly, ballooning, and lastly, a thinning and, in places, the partial disappearance of the longitudinal bands of muscle. The congestive processes in the large intestine were similar to those in the small intestines. Indeed the general external appearance of the gastro-intestinal tract suggested a grave derangement of bowel function.[38]

In this same series of experiments, the stomach was found to be distended, with its mucous membrane abnormally soft and necrotic. Ecchymoses were present, usually at the pyloric end of the viscus, and there were ulcers of various sizes. The duodenum was congested, with necrotic changes in its mucous membrane, but no ulcers were evident. Frequently the entire surface of the duodenum was studded with small pin point hemorrhages,

while the congestion and ecchymoses often extended to the jejunum and ileum. The changes in the large bowel were those of an intense colitis without ulcerations. This colitis involved the whole of the colon and the mucous membrane of the caecum, which was usually found to be moderately congested and ecchymosed. The lymphoid nodules of the colon were sometimes very prominent.

Wilcox reported two cases of beri-beri during the British campaign in the Dardanelles. At autopsy, the stomachs showed a marked redness of the mucous membrane, more extensive at the pyloric end. The duodenum showed an intense crimson congestion of the mucosa, while the jejunum, the ileum, and the large intestine showed similar effects. Bacteria had invaded the bowel walls and had penetrated deep into the mucous membranes. They were also found scattered throughout the submucosa. Even extensive collections of cocci were found in the enlarged lymph nodes.[38]

ACUTE GASTRO-INTESTINAL DEFICIENCY DISORDERS AND BALANCED METABOLISM

With the passing of time and with a more comprehensive study of physiologic and biologic chemistry, clinicians have gained a greater insight into psychic and physical phenomena. It has enabled them to ascribe the purely somatic gastro-intestinal diseases to conditions which show food deficiencies as causative factors. Unbalanced metabolism is, we like to think, a more fitting expression than the word "deficiency." Metabolic disorders result from food intake which is insufficient to supply nourishment to the cell structure. It took years, however, to discover with any degree of accuracy the real consequences which followed the utilization of improper and badly balanced foods.

It has been observed that diarrhoea and dysentery occurred frequently among monkeys fed on nutrient-deficient foods, and that these conditions were easily controlled by a proper balance of suitable foods. As we recall cases of acute infantile diarrhoea, they accompanied artificial feedings where the food used was of popular standardized brands but was not necessarily of biologic value. Vitamin C is often mentioned in connection with the feeding of the very young, and it is indeed a most essential nutrient. However, it must not be forgotten that the health of the gastro-intestinal tract is dependent on the adequate provision of vitamins of every class.

Medical workers in the tropics have long been familiar with

the fact that cysts of the *Entamoeba histolytica* type have been found in the stools of normal, healthy persons, where they may under certain circumstances possess the clinical characteristics of an amoebic dysentery. As a matter of fact, this disease organism may be present without a manifestation of symptoms until such time as conditions are propitious for its growth on and within a diseased intestinal mucosa, for it cannot otherwise become established. Persons living within the tropical zone find a certain protection from microorganisms in the careful selection and preparation of their foods. They strive to maintain a healthy activity of the entire gastro-intestinal tract. In doing so they tend to prevent certain infections, the result of poisons caused by disease organisms which are found in certain food stuffs.

Generally speaking, the pediatrician is called upon to deal with mild forms rather than with extremes, with conditions arising as a result of long continued use of foods somewhat poorly balanced and moderately deficient. He finds, too, that gastro-intestinal irregularities may occur not only as a result of deficiencies, but from a too great abundance of carbohydrates and fats in the ration. In a word, his findings point out the beginning of the disease, but not its end.[38]

DERANGEMENT OF BOWEL FUNCTION

The derangements of bowel function to which food deficiencies may ultimately contribute are probably these:—(1) the impairment of the protective resources of the gastro-intestinal tract against the pathogenic organisms; (2) the impairment of the secretory and the digestive functions; (3) an impairment of the assimilative power; (4) an impairment of the neuromuscular control of the stomach and bowel. The protective resources of the system include the normal production of the gastric, pancreatic, biliary, and intestinal secretions of the ordered processes of digestion and absorption. They include also the proper transit of the gastro-intestinal contents along the digestive tube.

If, then, infants are fed from birth on ill-balanced and deficient foods, one can realize the grave illnesses which may be caused by the derangement of bowel function. Food deficiency and the consequent lack of vitamins prepare the soil for bacterial growth, but the resultant morbid states will vary with the nature of the organisms implanted there. A knowledge of food deficiencies will provide us with a better understanding, if not a complete explanation, of such diseases as dyspepsia, dilatation of the

stomach, gastric and duodenal ulcer, mucus diseases, celiac disease, chronic intestinal stasis, and intussusception.[38]

LESIONS IN OTHER DIGESTIVE ORGANS

The salivary glands undoubtedly undergo a certain degree of atrophy from food deficiencies, with impairment of function; in consequence of which digestion is impeded at the outset. The saliva may be ropy, and may be reduced in its sulpho-cyanate content in contrast to that present in normal children. In addition, it gives a more alkaline reaction than that of normal saliva.

The healthy liver is rich in vitamins, and it is important that this vitamin content be maintained. In deficiency diseases a certain degree of atrophy of the liver takes place. Also, as has been shown experimentally in monkeys and in pigeons, a passive hyperemia is noted. Tuberculosis and septicemia, when of intestinal origin, are among the current infections that are known to produce hepatic enlargements similar to those found typically in beri-beri. Then, too, the glycogen content of the liver cells is reduced. Malnutrition of the cells, with a lack of regenerative power, is a final result caused by toxins that are either produced in the course of a deranged metabolism or absorbed through the weakened intestinal mucosa. Biliary insufficiency may logically contribute to a state of acidosis, and may at the same time facilitate the passage of toxic substances from the digestive tract into the blood stream.

The pancreas atrophies also in cases of food deficiencies. Occasionally it is dark slate-grey, and profuse ecchymosis, as well as necrotic-like areas, may be present on its surface. Mackenzie Wallis has reported similar changes in infantile diarrhoeas resulting from food deficiencies. Atrophy of the pancreas coexisted because of the loss and collapse of the parenchyma, and was associated with irregular, diffuse, abortive regeneration, leading to a considerable degree of pancreatic insufficiency, a condition found to be due fundamentally to a lack of certain vitamins, especially where the starches and fats in the food were in excess. The impairment of the function of the pancreas would be greater should the organ be attacked by the pneumococcus, streptococcus, or the staphylococcus, which are prone to cause toxic necrosis of the acinar cells of the liver.[38]

FOOD DEFICIENCIES IN RELATION TO SEX

In McCarrison's early experiments with pigeons on a diet of autoclaved rice, he found that males appeared to be more sus-

ceptible than females to the effects of polyneuritis columbarum, possibly due, he thought, to the fact that the males ate more of the autoclaved rice. It is a question to many of us whether the endocrines are influenced similarly in the two sexes by food deficiency, especially those organs concerned with the metabolism of the carbohydrates, as the pituitary body, the adrenal glands, the thyroid gland and the pancreas. Strange as it may seem, while the pituitary body enlarges as a rule in male pigeons fed on autoclaved rice, it does not change in female pigeons on the same ration. The average enlargement of the adrenals is greater in the females than in the males, there being beside, a decrease in weight of the pancreas and of the thyroid. However, in four female and three male pigeons, the author's findings were reversed.[38]

INDIVIDUAL IDIOSYNCRASY

One is too often prone to believe that deficiency diseases originate through the absence of some particular vitamin or vitamins without the influence of other agents. It is our intention to show this to be untrue. For instance, in the matter of personal peculiarities, individuals of the same age, sex, and species exhibit the widest variations in their sensitivity to food deficiencies. No doubt this is due, in part at least, to a natural individual variability of basal metabolism in certain children.

In one of McCarrison's experiments with pigeons fed on large amounts of polished rice and pushed to the point of the death of every bird, he found that one among 20 adult males developed polyneuritis in 27 days, while another succumbed only after 93 days. On the other hand, he found at the same time that among 15 adult females one developed the disease in 43 days, while three of the others remained immune until after a lapse of 100 days. In another series of experiments lasting for 75 days, he found that one bird developed polyneuritis in 24 days, another in 70 days, and a third escaped it altogether.

It is a well known clinical fact that children growing with abnormal rapidity are more susceptible to scurvy than those whose growth is slower. Other deficiency diseases show a similar characteristic.

The quantities of vitamins necessary for the harmonious regulation of the metabolic processes vary with each child and with his metabolic rate. This fact, it would seem, explains many of the anomalies in this class of diseases and indicates that the amount of vitamins which may be sufficient for one child may be

subminimal for another. Children vary, the writer believes, in the susceptibility of their different organs to disease and in the character of dysfunction of the same organ in different individuals.[38]

LACK OF FOOD BALANCE

Clinicians know that a balanced budget of carbohydrates, fats, proteins, and inorganic salts, especially the first three, will delay the onset of deficiency symptoms even without the influence of the vitamins and of environmental factors. However, an overabundance of carbohydrates and fats will hasten the symptoms. Funk has shown that an excess of carbohydrates alone will hasten polyneuritic symptoms, findings which were confirmed later by Bradden and Cooper. Funk and Schoenborn have reported hyperglycemia with a reduction in the hepatic glycogen as a consequence of a deficiency disease. Vitamins are known to have diminished hyperglycemia and to have increased liver glycogen. Without question the starch component of the food hastens the onset of symptoms both of the pre-neuritic and the neuritic stages, by overloading the oxidative mechanism in the presence of endocrine insufficiency.[38]

ONSET OF INFECTION

The onset of infection in children brings to the surface the symptoms of food deprivation much more quickly than might occur in more orderly conditions. Generally speaking, the infection will react in one of two ways. First, it may precipitate the onset of symptoms due to food deficiency; or, second, it may impart new clinical features to a food deficiency syndrome. In the one case there may be present an organism that is in itself capable of causing a condition such as polyneuritis, when acting among individuals already debilitated by deficient food. The other case may be that of a pathogenic organism whose peculiar effects have been superimposed upon an existent syndrome caused by food deficiency. Thus the pathogenic organism in the presence of the deficiency and its accompanying debilitating effects would produce pathologic conditions in an otherwise satisfactorily nourished and healthy child.

Drummond finds that slight vitaminic deficiencies tend to increase the incidence of intercurrent diseases of all kinds. During the occupation of Lille, France, in the World War, tuberculosis became very prevalent. We quote Lemoine's opinion in saying

that malnutrition was evidently directly responsible for this actual epidemic of glandular tuberculosis in 1917.[38]

INTESTINAL PUTREFACTION AND FERMENTATION

These two gastro-intestinal derangements are of great interest to the clinician, for not only are they common in themselves, but they often motivate other and associated organic disturbances far-reaching in their results. Diet, gastro-intestinal digestion, and environment can be considered with certainty as contributory factors of importance to the developing infant. To maladjustments and to functional derangements may be traced, either directly or indirectly, many of the nutritional or deficiency disturbances of infancy and childhood. The list is long and varied, and includes such conditions as chorea, subacute rheumatism or "growing pains," certain types of anaemia, acidosis, scurvy, rickets, some types of pneumonia, bronchitis, etc. When examining infants and children, veteran pediatricians focus their attention particularly on the functions of the stomach and intestines. Abnormal function along this tract plays an important role in the young, as seen in gastro-intestinal putrefaction and fermentation. No organic dysfunction can persist without associated dysfunction in other organs. Gastritis involves the intestines and the pathologic conditions of those latter organs involve the stomach.[40]

In low grade states of malnutrition, in whatever form, one may usually point to an intestinal putrefaction, or, on rarer occasions, to a fermentation, as its genesis.

REDUCTION PROCESSES

The intestinal tract is the seat of the reduction processes which regulate the oxygen and hydrogen content, thereby strongly influencing the chemical reactions within the intestines. The biliverdin and bilirubin of the bile are reduced to urobilin and the colorless urobilinogen. Bismuth salts are reduced to the suboxide, and the ferric salts to the ferrous condition. In regard to the bacteriology of the intestines, the oxygen supply is of particular importance, for it removes substances which favor the growth of anaerobes, among which are found organisms of putrefaction responsible for the formation of products which produce the toxemias of intestinal origin. Certain reducing substances such as formic acid, hydrogen, and hydrogen sulphide are known to be formed in the intestines by bacterial action. Putrefactive

poisons such as skatol, indol, and others reduce the child's vitality, moderate his immunity, and create fertile soil for the implantation of disease germs. These conditions are greatly intensified if the child is already the victim of an inherited dysfunction. Reducing substances such as simple sugars may be formed in the normal processes of digestion. Most of these reducing substances are soluble and are readily absorbed, so that the amounts present in the feces may furnish very incorrect indices as to the extent of their formation in the bowel.[40]

Experimentation shows that iron oxide to the amount of 1 per cent of the diet may be reduced to the extent of 80 per cent or more in the intestines. One reason for this reduction is the formic acid produced by organisms in the small intestines acting especially on the carbohydrates which cause intestinal fermentation. Of much more vital interest, however, is intestinal putrefaction due to the action of the bacteria of the lower intestine on incompletely digested protein. Bergeim found that no reduction took place in the stomach and practically none in the upper small intestine. The greater part of this reduction takes place in the caecum and large intestine, where intestinal putrefaction predominates. Intestinal immotility is always associated with this pathologic condition.[41]

COMMON TYPES OF DEFICIENCY DISEASES

Maladies involving nutrition, the so-called deficiency diseases, are powerful obstacles to the growth, development, and general well being of the child. A huge amount of evidence has been obtained, both experimentally and clinically, to show that such diseases as beri-beri, scurvy, rickets, tetany, osteomalacia, laryngospasm, spasmophilia, simple goitre, and certain types of ophthalmia, once thought to be the result of infective agents, are, in reality, caused by the omission from the diet of substances that are vitally essential to health. As time goes on, many other diseases will probably be added to an ever swelling group and invariably will be recognized. So often the food factors concerned in preventing or curing this group of affections are potent in such small quantities when compared to the total body need that their omission in the child's dietary may be easily overlooked. Unfortunately the pathologic manifestations of these so-called deficiency diseases may develop so slowly and so insidiously that they become well defined only in later stages. In the earliest stages often so few symptoms are present that a diagnosis is apt to be somewhat uncertain. Many of the deficiency diseases such as

rickets, scurvy, and xerophthalmia cause alterations in the child's structural organism that may persist as permanent lesions. Evidences of these early conditions are to be seen in healthy adults in the form of faulty tooth eruption and decay, bowlegs, knock-knees, etc.

It is known that lack of a certain vitamin will bring about definite conditions. It has been found both experimentally and clinically that lack of vitamin "B" will cause polyneuritic convulsions, lack of vitamin A, a breakdown of resistance to infection. Such disturbances arise also from the alteration of the normal calcium and phosphorus harmony in the blood, as seen in rickets.[42] In low phosphorus rickets, the child is unable to utilize his calcium adequately in spite of the fact that the blood contains a normal amount of it. In low calcium rickets, the total calcium of the blood is deficient, but by the addition of the fat-soluble organic factor the diet should supply enough calcium to provide for a normal amount in the blood.[43] Since the keenest observer finds it extremely difficult to discover the effects of the early symptoms of this deficiency, it is advisable in doubtful cases to prescribe a well-prepared, wholly metabolizable, and diversified dietary in order to provide all needed food factors. This properly balanced dietary will remedy or remove entirely these potential structural deformities and blood deficiencies.

Such factors as an almost complete loss of appetite and the subtle changes in muscular tone in scurvy, which are sensed rather than definitely diagnosed, lead in time to a weakening of the capillary walls, and are indications that a functional maladjustment is present.

After these functional disturbances, the physician sometimes wonders if the apparent return to normal health is a reality. While the disease may be cured symptomatically, it seems probable that there remains a disruption of digestion and of intestinal absorption, facts seemingly supported by hemorrhagic gums, loosened teeth, and their vicious sequelae along the intestinal tract. Radiographic evidence of scurvy in children has been obtained as long as ten months after the disease has been clinically cured. In a study of body weight and body length in infants, Hess, in 1916, observed that as scurvy developed there occurred a concomitant cessation in weight increase and also a decrease in linear growth. He found, however, that with the addition of orange juice to the diet, the former rate of growth was not only restored but increased. Our clinical experiences seem to warrant the assertion that during these food-deficiency upsets there is an acceleration of growth, although not along

normal lines, accompanied by a greater urge for food consumption.[42]

RICKETS

Rickets leads all deficiency diseases, but tetany, laryngospasm, scurvy, spasmophilia, and others follow in its wake. They are all dependent on a disparity of calcium and phosphorus in the blood. Rickets indicates a disturbed relationship between the calcium and phosphate ions in the blood stream, tetany is due to a disturbance in the balance of blood calcium, laryngospasm and spasmophilia are associated with tetany and a low calcium content in the blood. Howland and Kramer have demonstrated that normal blood calcium must be in the amount of 10 milligrams to 100 cc. of blood. If this content falls to six or seven milligrams, laryngospasm and spasmophilia are imminent; if reduced to as low as five, tetany is the result.[30]

This calcium-phosphorus imbalance is impressively shown in an experiment made by Medes. Numerous other investigators working along the same lines had reported that rats became rachitic on diets high in phosphorus and low in calcium. In this series of experiments, three groups of animals were used. The first group on Diet "A" received a slightly smaller amount of phosphorus than of calcium per 100 grams. The second group on Diet "B" were placed on a ration very low in phosphorus and fairly high in calcium. The third group on Diet "C" received a very high phosphorus and a very low calcium intake. After three weeks, all the animals were photographed by x-ray, and then made ready for ash analysis, for the purpose of studying the calcium, phosphorus, and magnesium contents. The x-ray plates showed that the bones of the rats fed on low calcium and high phosphorus were practically normal. In marked contrast to those on a normal diet and on one of low calcium content were those animals which had received Diet B, for they had become rachitic. The calcium and phosphorus content from those fed on Diet C was slightly less than was found in normal rats of the same age.[44]

When treating rickets in children, it is wise to bear these experiments in mind. Probably no two children show absolutely identical traits and reactions to disease symptoms. In some cases organic conditions may be such that rickets will persist passively until discovered by the x-ray. Sometimes this may be due to the failure of calcium absorption in the child's body, its associate phosphorus being actually excreted into the upper

intestines. Presumably the greatest part of the calcium absorption takes place normally in the upper part of the small intestine. On a milk diet, high in calcium and phosphorus, Bergeim was able to show experimentally a marked absorption of calcium and phosphorus in the small intestine. In the lower bowel, however, the balance was found to swing one way or the other, depending upon the ability of the tissues to utilize these nutrients.[47] It is impossible to place any confidence in a specific food regimen for children during any given period or for any given number of children, although they live in practically the same physical, psychic, and economic environment, and although their ages are the same. Mathematical formulae have never fed infants or children according to their biologic necessities.

Very possibly this is because every child inherits some mild or severe organic dysfunction. The feeding of infants in hospitals on a fixed scale according to age, weight, race, and growth impulse is impossible because of the many unknown organic potentialities. A theoretically perfect scientific milk modification may be entirely satisfactory in one case and unsatisfactory in ten others. Often some minor food essential is missing in the modification which cannot be supplied from the child's cell storage.

In his experiments, Jones brought about a condition in puppies which is akin to rickets in children in its effect on the osseous structure. The diet he used was apparently adequate in respect to protein, fat, carbohydrates, inorganic salts, and vitamins, but it possessed a high potential alkalinity. Similar experiments with the same diet but with different puppies resulted in normal bone development.

Clinical experience has taught us that children vary tremendously in their susceptibility to any disease, and this seems to apply particularly to rickets and pneumonia. The mother's physical state and her diet during pregnancy will also influence the child's systemic reaction to disease. In artificially fed infants it has been shown that rickets may result from a high degree of alkalinity in the intestines on a well constituted diet. This being the case, it is possible that the condition is the result of insufficient hydrochloric acid in the gastric secretion or an excess of alkali in the intestinal juices. A diagnostic certainty is essential for cure.

Infants having relatively little hydrochloric acid in the gastric juice may develop normally when breast fed, if the mother herself has a relatively normal metabolism. If the diet of the child be changed to foods forming a higher potential alkalinity, the amount of acid present may be insufficient for normal mineral

metabolism. Since, according to Jones, cow's milk is potentially alkaline in reaction and contains a large amount of buffer substances, as compared with human milk, one can easily explain why infants fed on cow's milk are more prone to rickets than are breast fed infants. Individual differences in the hydrochloric content, which the author attributes to heredity, may explain why one of a pair of breast-fed twins may be rachitic, the other not. The products of catabolism of the child's body tissues are acid in reaction, and may help to restore the normal acid base balance. Additional evidence of mineral salt metabolism may be seen in the coagulation time of the blood. The ingestion of calcium chloride, magnesium sulphate, and sodium chloride in certain dilute solutions favor this coagulation (the shortening of coagulation time). However, in more concentrated solution they counteract it.[46]

While it is held by many observers that rickets is primarily a disturbance of calcium and phosphorus absorption, because of the high percentage excreted in the feces, it is nevertheless possible to lower this percentage by the administration of antirachitic vitamins, ultra-violet light treatments, and suitable changes in the proportions of calcium and phosphorus in the diet.

Although it is impossible to draw a definite conclusion as to the results of treatment, an increased deposition of these elements in the bones seems a most probable one. The failure of calcium and phosphorus absorption, which appears as a result of a depressed intestinal function or the unsuitable character of the intestinal content, is not necessarily the sole cause of rickets. Factors for consideration may be an insoluble salt, such as calcium phosphate, or diets meagerly supplied with any form of calcium. In fact, any study of this question of absorption should cover all possible phases of the subject. This seems particularly advisable when we consider that antirachitic factors are not abundant in most of the common foods. Even on a milk diet rich in calcium and phosphorus the subsequent development of rickets has led us to suspect a defect in calcium assimilation. Apparently then, rickets may occur with a milk diet, partly, no doubt, because milk does not always contain any considerable excess of the antirachitic vitamin. Another point is the fact that the composition of milk used in infant feeding may be sufficiently altered to influence calcium absorption.[49] That the administration of antirachitic vitamins may overcome a rachitic potentiality is certainly not conclusive proof that this is the best means of securing the desired results.[30]

It is well known that an increase in the acidity of the gastro-intestinal tract increases the solubility of such salts as calcium phosphate. Lactose, when administered in considerable amounts, is known to produce a distinctly acid condition involving the entire intestinal system. Dextrin supplies a similar though less effective result.

Other carbohydrates, such as sucrose, glucose, maltose, and starch, have but little effect on the acidity as compared to lactose, because they or their products of hydrolysis are very rapidly absorbed. In any discussion of feeding problems the effectiveness of lactose in increasing calcium absorption should be a matter for serious consideration in milk modifications. This is equally true regarding the dietary for older children, as calcium seems to be a limiting factor in most instances. This does not necessarily mean that lactose is always the sugar of choice. Indeed, the writer has experimented with brown sugar for years with excellent results. Brown sugar contains many nutrients, is apparently well digested and absorbed, and produces but little fermentation in the bowels. Also its use in gastro-intestinal disturbances has been very satisfactory. However, neither lactose, brown sugar, nor any other form of carbohydrate will wholly replace antirachitic vitamins or phosphorus. It is an interesting fact that the sugars which most readily undergo alcoholic fermentation with the formation of lactic acid are the ones which are digested and absorbed slowly.

We do not attempt to explain the lessened calcium and phosphorus absorption seen in connection with certain high carbohydrate diets. From our pediatric experience, however, we do know that strong sugar solutions depress the gastric secretion of hydrochloric acid. Moreover, in the case of a high carbohydrate diet there is a danger of inorganic salts and vitamin deficiencies. It is also a fact that sugars have a depressing effect on the appetite.[47]

The calcium-phosphorus combination is present in the bones of rachitic and non-rachitic children alike. It is also the same in the bones of the newly born and in those of the adult. In fact, the constancy of the calcium-phosphorus ratio in the bones of the same individual, both rachitic and non-rachitic, is impressive. In pediatric literature we often find statements to the effect that there is a lower ratio of calcium phosphate to calcium carbonate in the bones of children with rickets than in those of normal children. Experiments on animals have shown that, while the inorganic phosphorus concentration of the serum is

diminished in rickets, the bicarbonate suffers no reduction.[56] Special studies along these lines have shown that a similar ratio is sometimes, but not always, present in rickets in the human.

Considering generally the many deficiency diseases of infancy and childhood, one finds rickets to be the master disease and all others secondary. The vitamins play a prominent part in its prevention and cure, but the balancing of metabolism is unquestionably a leading factor.

MUCUS DISEASES

Among the systemic disturbances commonly traceable to malnutrition is a gastro-enteric congestion called catarrh. Foods, especially those poorly selected and improperly prepared, have long been known as provocative of this condition. Specific instances are sterilized milk, rancid and over salted butter, polished rice, white bread, over-refined sugar, and vegetables that have stood too long after cooking. The direct origin of this condition, now spoken of as colitis, is still uncertain. Clinically it appears to be more prevalent among older children, and is associated generally with chronic anemia. The inevitable signs are acne and profuse seborrhea, loss of weight, general lassitude, backache, and frequent colicky abdominal pains after meals. The bowels are apt to alternate between fluxes and constipation, and mucus stools are common. The disposition changes and neurotic conditions are sometimes noted. While insufficient vitamin B is a causative factor, it is essential to consider the other vitamins as well. One finds that girls, particularly those beyond puberty, with colitis of long standing, may have congestion of the ovaries and uterus, while the younger ones often show a thyroid enlargement.

Because they involve the gastro-intestinal tract, we submit the two major dysfunctions, Celiac disease and Hirschsprung's disease, realizing, however, that they do not conform to the description of pure somatic disease.

Celiac disease occurs usually between the ages of nine months and two years as a diarrhoea resulting in cessation of growth. There is an associated abdominal distension and symptoms of scorbutus. The stools are like oatmeal in consistency. The children look ill and pale. Such subjects show an afebrile temperature, a liver diminished in size, blood changes, occasional edema, and muscular feebleness.[38] The condition may take on the aspects of a purely somatic disease.

Hirschsprung's disease is a congenital idiopathic dilatation of

the colon. In about one third of the cases the enlargement is limited to the pelvic colon, and in that region is found the greatest distension. Its etiology is questionable. Hurst believes that it is due to acholasia or the absence of the active relaxation of the circular muscle fibres at the pelvic-rectal juncture. This leads to a partial obstruction, with consequent dilatation and hypertrophy of the pelvic colon. The colon when once dilated produces a kink by overhanging the undilated portion below, thus producing difficulty in defecation, a gradual accumulation of fecal matter, and progressive dilatation and hypertrophy of the muscle fibres of the colon, finally terminating in broken compensation with loss of all peristaltic power. W. J. Mayo states that the failure of coordination in the nonstriated muscle fibres of the recto-sigmoid mechanism is responsible for the development of this malady.

These two dysfunctional conditions are not amenable to treatment from the same standpoint. The former eventually responds to the balancing of metabolism. The latter, if severe in form, may be relieved even in older patients, by a preliminary ilicolotomy with later removal of the entire colon and subsequent attachment of the ileum to the rectum.[49] In mild cases and in very young subjects we consider it best to depend upon nutritional methods, which have shown some degree of success.

Chronic Intestinal Stasis is a condition of rather common occurrence. A ballooning abdomen points to its presence. Arthur Keith has drawn attention to two anatomic factors of primary importance in its causation:—first, a defective action of a part of the abdominal musculature; and second, a lesion of the neuro-muscular system of the intestine. A deficiency of certain food elements leads to atrophy of all muscular tissue as well as to a disordered function or to an actual degeneration of nervous tissue throughout the body. The abdominal musculature and the nerve elements controlling it must of necessity suffer along with other muscular and nerve tissues. Keith describes the changes in the muscular coats of the diseased large bowel as a fibrosis which affects mainly the tissue between the outer and inner coats; namely, the intermediate stratum which ensheathes the mesenteric plexus. A degeneration in the areas of this musculature, particularly that of the outer longitudinal coat, also occurs. In all cases inflammatory changes are present. There are also many marked changes in the glandular epithelium and in the submucous coat. There is an engorgement of the subperitoneal vessels and an abnormal thickening of the subperitoneal tissue.

Gastric and duodenal ulcers have not been numerous in the writer's pediatric practice. Those which were observed were due in part at least to ill-balanced food essentials. Other causative factors, no doubt, are mechanical, toxic, nervous, and bacterial agencies capable of producing superficial hemorrhagic erosions and acute ulcers of the stomach and duodenum, and are comparable in some degree with those which occur as a result of thyroid and adrenal insufficiency. They may, indeed, be due partly to the functional derangement of these endocrine organs in consequence of food deficiencies. An avitaminosis, particularly one which has existed over a long period, must surely be held responsible, at least in part, for the production of the chronic ulcerations of the viscera, since we know the clinical picture presented by an established state of deprivation; that is, lowered resistance to infection and unhealthy mucosa of stomach and duodenum, a combination indeed all too ready to receive and spread bacterial organisms such as the streptococci, which are spread directly in food or by way of the blood stream. In fact, the changes produced in the stomach might lead to an achylia, so that an infection by mouth would be rendered comparatively easy. Ivy has experimented on dogs along this line. With these degenerative changes present in the gastric mucosa it is impossible for the digestive juices to be normal in quality or in quantity.[38]

Intussusception is a dreaded abnormality rarely found within our own communal groups. However during the World War there was a great increase of it among the children of Germany. The neuromuscular control of the child's bowels is dependent in great measure on adequate rations.

APPENDICITIS

Appendicitis. Today this rather familiar disorder may be rated, we believe, among the unnecessary evils of childhood. Its inception comprises a poor and weakened neuromuscular system, constipation or diarrhoea, which alternate at times, being accompanying manifestations. The fundamental causative factor in this condition, it would seem, is a badly chosen and improperly balanced food regimen. This is not difficult to understand when one realizes that the ill-balanced diet must surely predispose to a state of continuous chronic gastro-intestinal derangement. This means that the muscular fibres in the mucosa and submucosa are prevented from reacting normally and the mouth of the appendix, instead of being tightly closed, be-

comes relaxed. In this event it is merely a matter of time for the bacteria in the passing fecal excretion, a part of which drops into the lumen, to become implanted within the body of the appendix.[38]

EFFECTS OF FOOD DEFICIENCIES IN COMBINATION WITH EXCESSES

Before closing this particular aspect of our subject, we turn for the moment to another phase; namely, the effects of a combination of food deficiencies and excesses on the thyroparathyroid glands. Our own experiences clinically have somewhat paralleled the following experiment. A diet deficient in vitamins B and C, in proteins, and organic salts, but with an over-amount of fats and starches added, was given to monkeys. The result was a combination of atrophy and congestion. Owing to the effect of a deficient and ill-balanced food ration on the thyroid gland, it is possible for intestinal bacteria to gain access to the organ by way of the blood stream and subsequently to cause congestion. It has been observed also that insufficient quantities of fresh fruit and leafy vegetables in the child's dietary tend to impair the functional capacity of the adrenal glands.

An intimate relationship exists between the organs and metabolism balance, and it is therefore possible for an excess of edible fats in the food to counteract a relative deficiency of iodine and an undue stimulation of the thyroid gland.[39]

Insufficient consumption of protein and vitamins tend to cause disturbances and malfunction throughout the organism. No single organ is immune, because of the close interdependence and correlation of all body organs.

ALLERGY AND ANAPHYLAXIS IN CHILDREN

The child's body, immature, highly sensitive to environmental influences, and often suffering from a poor inheritance and somatic disturbances, is subjected to the most extensive and divergent allergic phenomena. Appreciation of these multiple divergencies has now reached a point where specialists, special clinics, societies, and journals are maintained for their treatment and discussion.

Reactions of hypersusceptibility involve increasingly extensive areas of the child's body. In some of the most characteristic conditions of allergy the skin is usually involved, either alone or in combination with other organs. There are found idio-

syncrasies to such chemical substances as iodoform, antipyrin, quinine, formalin, and some arsenicals. While these are not particularly irritating, they can, nevertheless, be classed as anaphylactic, although, as Gay remarks, the exact reactions are not clearly understood. These substances are non-protein and therefore non-antigenic, but they may unite with the foreign proteins in the hypersensitive child to form a new antigen-complex. At all events an itching edema of the skin may follow exposure to them.

Often angioneurotic edema, certain forms of eczema, and urticaria are referred to as allergic in character. There is often also a specific susceptibility to various physical agents, such as light, heat, and cold. In older children, asthma and hay fever may be produced not only by the pollen of various plants, but by dust and even by the effluvia of animals.

Hypersusceptibility to food stuffs such as shellfish, wheat, egg white, berries, and sometimes even milk is common. Horse serum injections frequently produce violent disturbances in the skin and along the respiratory and gastro-intestinal tracts, resulting in nausea, vomiting, colic, diarrhoea, and abdominal distress, often recalling the inherited asthmatic tendency due to a status lymphaticus.

Allergic provocatives occur not only in foods and drugs, but also in dusting powders, dandruff from the hair of animals, and even from the feathers of birds. Bacterial proteins can give rise, at least experimentally, to specific susceptibility and to anaphylactic shock.

In the future, when scarlet fever, coryza, and acute muscular rheumatism, along with diseases of suspected or recognized inherited influences, are considered, will it not be possible that they may be looked upon basically as allergic sequelae of an injured germ plasm? The familiar skin reactions following injections of serum for tuberculosis and scarlet fever are certainly instances of allergy.[50]

FOOD ALLERGY IN INFANTS AND CHILDREN

Food idiosyncrasy is not necessarily a question of the food itself, but is due at least partly to its preparation. Constitutional or conditional dysfunction of the digestive system, or a combination of both, are the forerunners of the peculiar condition of food sensitization, for, as Ratner points out, there is seen a peculiarly altered reaction even to non-toxic substances ex-

perienced by none but these individuals suffering from malfunctions. Many children can tolerate egg in some form if not given in excess, others tolerate it even in large amounts. A child suffering from a serious dysfunction, however, may be hypersensitive to a very small amount of a certain food, and suffer a more or less profound reaction after ingesting it. Anaphylaxis, we believe, is founded in most instances on a faulty character inheritance, and results in at least a dysfunction of the digestive tract, possibly involving other adjacent or distant organs.

Thus when a child receives some form of protein into the circulation, there arises after a certain incubation period a sensitization to that protein. When an added amount of this antigenic protein is given, there result certain phenomena, mild or severe according to the degree of sensitization, for instance, mild headaches, furred tongue, loss of appetite, irritability, restlessness, night terrors, a dryness of the skin with consequent itching, or an inability to concentrate on school work.

Every pediatrician can recall many cases of food allergy in mild form, but those of a severe nature are rather infrequent. We recall a patient of ours, a boy who for eight years was unable to eat meat in any form without nausea and sometimes even vomiting. Even very small amounts of meat caused the same reactions; and once when forced to ingest a large amount of it, a projectile vomiting took place which weakened the child considerably. Certain authorities have cited instances of death, but this is rare in our experience.

Often in infant feeding, where, to the best of one's ability, a good formula for that particular infant has been made, such phenomena may arise. The addition of raw or pasteurized milk to the modification has brought about these results. Ratner mentions a case in which the lact-albumin was at fault, and when the milk was denaturalized the symptoms disappeared. It is possible that poor pasture or the eating of harmful grasses may bring about a changed metabolism in the cow, with a consequent faulty formation of lact-albumin. Strange as it may seem, less food intolerance is observed from the ingestion of hard cooked than of soft cooked eggs, and more from dropped or coddled eggs than from scrambled. Children suffering from reactionary food intolerances such as extreme urticaria, general malnutritional eczemas, asthma-bronchitis, pseudo-scurvy, etc., are often found to have eaten the egg not as food alone but mixed with other foods with which it cannot chemically affiliate. Such conditions may result after eating cakes, cookies, ice cream,

noodles, macaroons, bread, etc., but the age and condition of the egg before being added to the food must certainly be considered.

Where intolerance for a certain food is discovered in infancy, and particularly in childhood, it is often wise, instead of adding bit by bit of the intolerant food and seemingly developing a tolerance for it, to omit it altogether for a time and substitute other foods. Often we have seen such reactionary conditions change in the course of time to tolerance.

The theory of a combined constitutional and conditional dysfunctional origin of food allergy may be challenged by the advocates of two other theories. Schloss suggests that the intestinal tract of diseased infants is extremely permeable to the invasion of unchanged proteins and that in certain children this protein enters directly into the circulation and will sensitize these children. In fact, there is little reason to doubt that unusual forms of protein may make their way into the blood stream from the alimentary canal. Such absorption seems to take place more readily from the large intestine than from other parts of the alimentary canal. In digestive disturbances, incompletely digested or unchanged proteins may reach the large intestine. It has been claimed that an over-indulgence in eggs or meat may create a sensitiveness to those foods by inducing an overproduction of the reacting substances, which persist and cause disturbances later when the proteins are eaten. Often, too, there may be a family history of asthma, hay fever, or similar sensitivity.

Possibly a food allergy in the infant may be congenital in character. Infrequently in our experience, gastro-intestinal upsets in the suckling soon after birth have been traced to allergic symptoms of the mother. It may be that the mother's diet was unbalanced in proper food essentials during pregnancy. An excess of unmetabolizable proteins may have been circulating in her blood stream to gain entrance to the fetal circulation through the placenta.

If the infant develops such a sensitization even when the mother's metabolism is well balanced, it is wise to analyze the various nutrients in the child's diet, and to pick out the offending member through the elimination of each food in rotation. Among older children, certain reactions from food allergy are seen along certain nerves, notably those of the hands, feet, arms, or legs. There often develops a tingling or a numbness. At times also, coryza, colds and fevers, anal pruritis, or neuralgia may occur.[51]

In the treatment of food sensitization, of dysfunction, therefore, a severe burden is laid upon the shoulders of the clinician. Sometimes, as Finck has said, the most deadly poison, nutritionally speaking, lurks in the child's daily food. This author believes that the basis of allergic nutritional conditions is faulty absorption from the gastro-intestinal tract as well as damage to the liver, so that partially digested proteins are not completely destroyed. Schloss and Anderson have shown that artificially fed infants absorb foreign proteins during attacks of diarrhoea, and such absorption is often found to be followed by the appearance in the blood of precipitates and of the anaphylactic antibody. In many cases of food sensitization we have discovered similar attacks in the parents, but not, strange to say, due to the same protein.

The symptoms of food anaphylaxis are manifold in character and may be either mild or severe. Many of the ocular symptoms are those aggravated by toxic conditions in more remote parts of the body. There may be acute conjunctivitis, naso-pharyngeal and possibly sinus congestion, acute bronchitis, bronchial asthma, as well as gastro-intestinal conditions including colic, vomiting, nausea, gastric distress, diarrhoea, or constipation. Enuresia, too, is very frequent. Besides urticaria, eczema, and many forms of dermatoses, erythema, intertrigo or chafing of the anal orifice are among the conditions which may arise, and some authorities add angioneurotic edema. All these cases, it seems to us, can eventually be traced back to the constitution and conditions of the child's heredity and environment. Our cases have usually responded to a selected diet and to a subsequent well balanced metabolism. In older children where food sensitization has not been discovered early or successfully treated, it becomes more or less fixed and is not easily amenable to treatment. Many of these cases, if not all, are biologic, the result of food unbalance, an unbalanced metabolism.[52]

Past masters in diagnosis included honey, tea, coffee, fish, even clams and oysters, various fruits and vegetables, as allergic, while idiosyncrasies to drugs, alcohol, and tobacco were fully recognized as such. Gould and Pyle, in 1900, drew attention to nutmeg, parsley, figs, and chocolate as factors in causation. Many kinds of nuts, possibly from their high fat content or the peculiar character of their other nutrients, have been the apparent cause of allergic symptoms, such as vomiting, burning, and puffiness of the face and adjacent organs, with pseudo-asthmatic attacks of coughing and suffusion of the face and lips.

It is, we believe, highly possible that an excess of a high

nutrient content of any foods may cause allergic symptoms from abnormal assimilation and metabolism, as a result of an inherited gastro-intestinal dysfunction. It is fairly common in allergic conditions in older children to find a marked hypochlorhydria resulting from the ingestion of eggs, meat, fish, milk, and cheese. Schloss and Worthen concluded that the intestinal tracts of normal infants were usually impermeable to undigested protein. Often it has seemed good practice to weaken, dilute, or mix foods in smaller proportions, to overcome the allergic difficulties of a food high in some particular nutrient. A change from whole wheat bread to that made of finely milled flour, milk diluted with water or vegetable water, steamed cereals combined in small individual proportions, as a mixture of corn meal, oatmeal, and farina, are procedures which have aided us.

As the child grows to maturity, these food idiosyncrasies assume less importance but often develop into a distaste for certain foods. In our opinion many cases of supposed allergia are only pseudo allergic, and a change in environment, altitude, and outdoor life may remedy them. Pure allergic reactions are without fever. Dislike for a given milk modification in infancy or for a mixture of one or more foods added to it may or may not indicate hypersensitiveness. Sometimes a food over- or undercooked, usually the latter, may cause a sensitization, and it has occurred in our practice that a five-year old child reacted allergically to soft cooked but not to hard boiled eggs. It has seemed, at times, that food given in the pure form may cause no reaction, whereas when mixed with other foods, thereby causing biochemical changes, it does. It is well for the young pediatrician to have a thorough understanding of the symptomatology of allergic reactions and not to confuse them with similar conditions brought about through microorganisms. There is great temptation to blame foods for allergic effects when in reality none are present. A number of gastro-intestinal disturbances in childhood are not allergic at all but are caused by poorly selected foods, many of them faulty in character. Other factors are faulty bowel elimination and the action of the intestinal microorganisms on the unmetabolizable mass. In one of our patients, honey which was supposed to be non-allergic, in reaction proved to have produced an acidity of the bowel contents with a subsequent itching of the child's body and a pruritus ani. After a reduction in the amount given the symptoms cleared up.

Most allergic conditions in infancy and childhood, as seen by the city pediatrician, are apparently found among those un-

fortunates whose homes are in apartments and whose psychic and physical environments are restricted. In the unrestricted freedom enjoyed by children living in the country, allergic reactions are by no means so outstanding as in the city.

Many allergic skin reactions and subcutaneous desensitization methods in our hands have proven disappointing. O'Keefe and Schloss have cited cases of intestinal allergy without a positive protein skin reaction. When expected results of allergic skin reactions do not materialize, we do not know whether it is because of the technique employed or an impotency in the reagents used, but we do know that an attempt to balance the diet by combining as many foods and food principles as can be easily digested, assimilated, and metabolized has proven of great value.

We have had but little experience in desensitization by subcutaneous injections of autoclaved cow's milk or other preparations, but have experienced some success in desensitizing by mouth with gradual increase in the dose of the toxic protein or other food in question. The form of treatment which serves us best, however, is the balancing of the metabolism with other foods. Often with the betterment of organic function there comes a gradual biologic desensitization of proteins formerly found to be toxic. The many theories of food sensitization are not in general greatly to our taste. On the other hand, the constitutional plus conditional dysfunction theory seems to clear up the atmosphere. There may be a dysfunction resulting from the metabolization of one protein and not of another. There may be a dysfunction for milk lact-albumin and not for casein, or vice versa, for egg protein as against meat protein, for meat protein as against fish protein. There may be a dysfunction caused by one or more proteins or other food principles in the same food product and not by others. Thus the artificial desensitization is often unproductive.

Older physicians were wise observers, and Burton, in 1600, wrote, "I conclude our own experience is the best physician, that diet which is most propitious to one is often pernicious to another, let every man observe and be a law unto himself." It was Tiberius in Tacitus, we believe, who observed that, "a discreet and godly physician doth first endeavor to expel a disease by medicinal diet than by pure medicine."

There is no one panacea for treating hypersensitive reactions. However, two useful methods which we have found of value might be termed "building up" and "bearing down." The first consists of selecting a few foods of easy digestibility and easy

assimilation and noting the absence of reactions. Then new and other foods are added in rotation and in increasing amounts. The second method is more difficult and requires handling by a widely experienced pediatrician versed in the symptomatology of allergia. Selecting a number of foods indiscriminately, he notes the reactions of the whole and eliminates one or more of these foods, or else changes the amounts of those he considers the instigators of the disturbance.[53]

Physicians have approached the treatment of food allergies in different ways; by means of fasting, or by the keeping of a record of the dietary, or adopting the food addition method of Brown, or the dietary manipulation method as suggested by Alexander and Egermann. We have used no prescribed method exclusively. It is quite believable that these allergic manifestations are behind many gastro-intestinal, bronchial, asthmatic, cutaneous, ureteral, bladder, pharyngeal, nasal, nervous, and ophthalmic disorders. This hypersensitiveness established in the body cells and dating from heredity is due possibly to some proteins or other substance which throws metabolism off balance. We are led to believe also that many idiosyncrasies of children are due to a sensitization to various foods. These idiosyncrasies, strangely enough, vary with age, foods, seasons, altitudes, and barometric pressure, or may persist under unfavorable treatment and environment in a mild or severe form throughout life.

Some forms of bladder conditions, fevers, fatigue, joint and muscle pains may be symptoms of allergia. Often a pediatrician is put to the test of finding out whether a child is simulating an idiosyncrasy or is truly suffering from one. Undoubtedly pure but temporary somatic allergic reactions have appeared in normal children from an excess of a food given, not only from wheat, milk, meat, or eggs, but from such foods as chocolate, potatoes, oranges, bananas, and apples. Condiments and spiced foods are frequent offenders.[53]

Whether the sensitization of the infant to colds and to respiratory affections springs from an hereditary source and not from a purely somatic one, is open to question. It is quite possible that the infant during the first few months of life, although constitutionally sound, may not possess the needed vigor to resist the onslaught of invading microorganisms. Time, inheritance, and environment then play an important part during the first years of life in determining the sensitivity of the infant to infection, particularly to colds, a predisposition to pneumonia and to other respiratory disturbances. In our clinical experience heredity has played a major part for some children. When

ottle fed, some seem paradoxically more immune. This im-
nunity, however, decreases under faulty nutrition and environ-
nental factors, and is possibly a throw-back from heredity. Many
cientists, Hess in particular, have found that any one factor in
nutrition, notably vitamin "A," is not enough to insure against
olds.

Hess draws the conclusion that the antirachitic factor, whether
given as ultra-violet irradiation, as irradiated ergosterol, or as
od liver oil, does not increase the immunity of infants to
espiratory infections. Respiratory infections are not due to a
ack of vitamin A and generally cannot be lessened by giving a
liet rich in this factor, even when supplemented with cod liver
oil. A lack of vitamin "C" may induce a heightened susceptibility
o infection of the respiratory tract, a local susceptibility only,
but may result in a typical nasal diphtheria without a positive
Schick reaction.[54]

ACIDOSIS AND ALKALOSIS

Closely allied to somatic nutritional diseases, are two distinct
forms of body unbalance which are commonly called diseases,
but which are better spoken of as conditions. A study of the
acid-base balance of the body should be included in every work
on nutrition. Acidosis is a familiar term, but alkalosis is less so.

Acidosis may be defined as a condition in which the reaction
of the blood is less alkaline than normal. In *alkalosis* the reac-
tion is less acid than normal. There is also an allied condition
called *ketosis* in which there is defective oxidation of the products
of fat metabolism, resulting in an accumulation of substances
within the body known as ketone bodies. Whether acidosis and
alkalosis are of purely somatic origin is conjectural, but we be-
lieve there is at least a slight inherited potentiality.

The regulation of the acid-base equilibrium is probably one
of the most delicate adjustments of the body's regulatory processes.
The tissue fluids of the child's organism must constantly be kept
in a state of slight alkalinity, and even a moderate departure
from the normal may, in certain instances, lead to serious inter-
ference with the various activities of the tissues. On the other
hand, alterations in the metabolism of the tissues themselves may
have a profound effect on the acid-base balance. The child lives
a normal life, other things being equal, when the reaction of its
body and of the contained fluids is kept practically constant, in
other words, balanced.

Metabolic processes, however, lead to the formation of acids,

as carbonic and lactic acids, and the diet may contain varyin
amounts of acid and alkali. The digestive juices dispose c
some acid, as seen in gastric secretion, and of some alkali, a
contained in the bile and pancreatic juices.

There is usually present a great excess of acid over base i
the child's body. In health, biologic adjustments are alway
taking place, but are of so delicate a nature that no moder
methods at our disposal can detect them. A disturbance of th
acid-base equilibrium should be considered as a physiologi
maladjustment rather than an alteration in the tissue fluids, an
the shadowy signs of these disturbances may assume great im
portance in growth and development. One often encounters ther
in infancy and childhood, and their treatment requires experienc
and ability. The processes of respiration and urinary excretion
by means of which practically all the acid is eliminated, are de
termined by many factors other than the presence of acid sub
stances in the blood. Foods and the psychic and physical stimu
which effect nutrition are some of these factors. Acidosis an
alkalosis, then, are both deviations from the normal, but the
are not disease entities. Both conditions are manifestations c
the body's reaction to pathologic processes and both may ac
as pathogenic agents.

DEFENSES AGAINST ACIDOSIS

In the course of normal metabolism in a healthy child, aci
products are being constantly produced in excess of base. It
wise, therefore, to fix the attention more on acidosis than o
alkalosis, for the former condition may endanger the child's lif
while the latter disturbance rarely does harm. It is eviden
therefore, that some mechanism must be perfected for dealin
with an excess formation of acid, a product of metabolism. Th
provision for the disposal of acid must be greater than that fo
combatting an excess of base, which is done simply by increasin
the production of some of the normal acid metabolites and usin
carbonic, lactic, and phosphoric acids to neutralize the exce
of alkali. An excess of acid, on the other hand, cannot be dea
with in such a simple manner, since practically none of th
products of metabolism are alkaline in nature. The defens
against acidosis constitutes the buffer action in the blood an
tissues, and the excretory functions of the lungs and kidney
The whole of the child's organic mechanism is so delicately a
justed and the various processes so interdependent that an

signs of the maladjustment of acid and alkali must be immediately remedied.

CARBONIC ACID: BICARBONATE OF SODIUM

Of the acids produced in the course of metabolism, phosphoric, sulphuric, lactic, and other organic acids are all immediately neutralized after their formation, so that they are always present in the blood and tissue-fluids as salts. Carbonic acid, however, is not completely neutralized and is found in the blood in quite large amounts, both as a free acid and in solution. With sodium bicarbonate it forms an important buffer. It is the ratio of free carbonic acid to bicarbonate which regulates the activity of the respiratory center. Consequently, any change which results in an increase of free carbon dioxide over the combined carbon dioxide will stimulate the respiratory center to greater activity; and vice versa, any factor which reduces the ratio will depress this center. If then the blood is called upon to dispose of an excess of acid, the bicarbonate immediately "soaks up" the acid.

PHOSPHATES

Inorganic phosphates are present in the blood in two forms:—the one as the alkaline salt ($Na_2\ H\ Po_4$) and the other as the acid salt ($Na\ H_2\ PO_4$), when the reaction of the blood is normal there is four times as much of the alkaline salt as of the acid phosphate. These two salts are powerful buffers, and although present in small amounts, they act in a similar manner to the bicarbonate.

PROTEINS

The addition of acid to the blood also causes an immediate decrease in the acid value of the proteins and consequently in the liberation of a certain amount of base previously held by these proteins.

HEMOGLOBIN

Hemoglobin, as a weak acid, acts as an important buffer in the reaction of the blood. This is shown by the changes in the carbon dioxide of the blood when the pressure of the carbon dioxide is reduced.

CHLORIDE SHIFT

In order to maintain the normal equilibrium between cell and plasms, the former must acquire more acid or get rid o some of their alkali. The cell walls allow acid to pass through although they are impermeable to base. There ensues, there fore, a passage of chlorine and carbonic acid from the plasm of the cells.

The red cells are permeable to carbon dioxide so that the ca bonic acid may be fixed by corpuscular base (potassium) whic has been released from the hemoglobin and from the alkalin phosphate. The buffering mechanism in the blood is due, ther to the presence of bicarbonate, phosphate, and the proteins, chie of which is hemoglobin. It can be readily understood that di turbances of the acid-base balance occur oftener and are mor serious when the hemoglobin is deficient, as is seen in the man types of anemia in infancy and childhood. The efficiency of an buffer system in resisting change in reaction is at its maximun when the contents of salt and acid, in other words, of sodiur bicarbonate and carbonic acid, are equal. Indeed, one may sa that the child's body as a whole is better protected agains acidosis than against alkalosis.

THE ROLE OF THE KIDNEY

The buffer mechanism of the blood, even with the help c respiration, however perfect, would be frequently overwhelme if the defence against acid accumulation ended there. Just a the hemato-respiratory processes are the chief agents in dealin with the carbon dioxide, so the kidney is the principal outle for the excretion of all other acid radicles. The sweat gland may play an important part as well in the metabolism c chlorine, especially when sweat is induced in large amounts.

AMMONIA EXCRETION

In intermediate metabolism, the amino group is converte into ammonia, which is available for the neutralization of aci to form salts. Under normal conditions the bulk of the ammoni fastens on to the carbon dioxide to become ammonium ca bonate, from which by the loss of two molecules of water tl innocuous substance, urea, is formed.

SUPPLY OF FIXED BASE

The increase in ammonia excretion takes some days to reach the maximum, so that something must be done to tide over this delay. This is provided for by a supply of extra base directly from the bones, such as calcium, and from the soft tissues, such as sodium and potassium, the necessary supplies coming from the child's food. In contrast to the ammonia output, the increased excretion of fixed base takes place immediately. In this excretion the sodium and potassium of the tissues bring with them water to prevent disturbances of osmotic equilibrium. This is the explanation of the diuresis which occurs at the commencement of an acidosis and when ammonia formation is not great enough, as is seen in interstitial nephritis, to cope with all the acid requiring excretion. This loss of base and of water is very serious. In the post-acidotic state, the loss of tissue base is made good by the continued formation in the kidney of excess ammonia. Thus, base derived from the child's diet is allowed to accumulate in the bones and soft tissues until the original loss is made good.

FORMATION OF ORGANIC ACIDS

Organic acids play an important part in the excretion of excess acid or alkali, for in acidotic conditions, except those due to ketone production, there is a decrease of organic acids in the urine, the result of either a lessened production or of better combustion. In alkalosis, on the other hand, organic acids are formed and excreted in larger amounts. The excess alkali is thus neutralized, and its excretion within the limits of the hydrogen-ion concentration of the urine is made possible.

ROLE OF THE INTESTINE

The intestine too plays an important part in the excretion of minerals such as calcium and phosphorus which must be replaced in the diet. In pathologic conditions, such as in many kinds of severe diarrhoeas, in simple vomiting, as well as in cyclic vomiting, this acid-base equilibrium may be seriously affected.

DEFENSES AGAINST ALKALOSIS

Little need be said of the defense forces against alkalosis, for this condition is of less importance than acidosis. A mechanism

does exist to prevent the reaction of the blood and tissues from becoming too alkaline. In non-gaseous alkalosis the excess of base is compensated for by the retention of carbon dioxide, this being affected by the depression of the respiration. In gaseous alkalosis, on the other hand, excess of base cannot be rectified, for it is pulmonary over-ventilation itself, and consequent excess excretion of carbon dioxide, which determines the condition. Buffer and renal action must be utilized in such instances.

BUFFER ACTION IN ALKALOSIS

This is similar to that in acidosis except that the reactions take place in the opposite direction. For example, proteins become more acid and are thus able to hold more base, and the chlorides shift from corpuscles to plasm. The urine also becomes more alkaline, due to the excretion of greater amounts of alkaline phosphate and carbonate. Simultaneously there occurs a decrease in the formation of ammonia which necessitates a rise in the excretion of fixed alkali in combination with acid, and the call upon base is further increased by the additional formation of organic acid. Another important acid-sparing substance is carbonic acid. This unites with the base, requiring excretion in the urine, and thus does away with the necessity of utilizing some other acid-radicle such as chlorine or phosphorus.

PHYSIOLOGIC VARIATIONS OF ACID-BASE EQUILIBRIUM

About one hour after the child's well-chosen breakfast there is a rise in the bicarbonate of the blood, as a result of the loss of chlorine secreted in the gastric juice, assuming, however, that the gastric secretions are normal. Simultaneously the urine becomes highly alkaline, a condition marked in children with hyperchlorhydria but absent in those with achlorhydria. When the food has passed into the intestine and reabsorption of the chlorine of the gastric juice is taking place, the bicarbonate and chlorine of the blood gradually regain their normal levels and the urinary reaction returns to its usual acidity. In health, carbohydrate and fat are completely oxidized to carbon dioxide and water, which are removed so quickly that no disturbance of the acid-base equilibrium is apparent. The oxidation of protein leads to the formation of sulphates and phosphates, so that a high protein diet—remember—has an "acid" effect. The amount of minerals, whether acid or alkaline in nature, in

fluences acid-base equilibrium in the corresponding direction, but the excretory system is usually capable of preventing any manifest changes. Inanition by the production of acid metabolites leads to a lowering of bicarbonate and to the appearance of large amounts of acid and ammonia in the urine. In some older children a severe inanition acidosis may develop rapidly.

MUSCULAR EXERCISE IN ACID-BASE BALANCE

Muscular contraction leads to the production of lactic acid, some of which is resynthesized to glucose and some oxidized to carbon dioxide. If the muscular exercise is of such a nature that sufficient oxygen cannot be taken in to complete the oxidation of lactic acid immediately, this substance appears to excess in the blood, and accordingly the bicarbonate of the blood is reduced and the pulmonary ventilation increased. The urine shows an increase in acidity and ammonia. Again, the application of heat, such as a hot bath, leads to excessive pulmonary ventilation, with a consequent washing out of free carbon dioxide, and to the production of a gaseous alkalosis,—protective measures against acidosis. The exposure to low oxygen pressure at high altitude also may be a beneficial measure in thwarting it, as it leads to rapid shallow breathing with the subsequent washing out of the carbon dioxide and to the production of a gaseous alkalosis. Then the urine becomes alkaline, but unfortunately sickness and vomiting may follow.

Should one desire to take tests in children for acidosis and for alkalosis, he had best use venous blood, for arterial blood is hard to obtain. The total carbon-dioxide content of the whole blood is decreased in conditions of non-gaseous acidosis and of non-gaseous alkalosis. A combination of the total carbon dioxide content plus the clinical signs are our best determinants. The common acidotic conditions of later childhood, we believe, belong to the non-gaseous group.

As seen in diabetes and in certain forms of gastro-enteritis, a low carbon dioxide content may be taken as conclusive evidence of acidosis; or in alkalosis such as occurs in pyloric stenosis, the carbon dioxide content may be taken as an index of the degree of alkalosis. As is well known, variations in the excretion of acid and of alkali in the urine have been made use of as an index of the acid-base balance. The more acid excreted by the kidney the lower is the pH (reaction of the blood) of the urine and the greater its titratable acidity. One should not forget also that the ammonia output is increased in acidosis.

CLINICAL SIGNS

In trying to interpret the forewarning signals of acidosis, we have often been discouraged and have felt insecure. Indeed, the clinical signs and symptoms depend largely on the nature of the acidosis; but there is little worry about those of alkalosis. In the gaseous type of acidosis, which is rare, the breathing is slow because the respiratory centre is depressed and therefore requires more carbon dioxide to stimulate it. In the non-gaseous type, the patient is usually drowsy, sluggish, or even comatose. One sees a descriptive picture in diabetic acidosis in older children, where the breathing is usually noisy and continuous and may be mistaken for pneumonia or influenza. In the commoner type of non-gaseous alkalosis, the breathing is depressed to conserve the carbon dioxide in an attempt to restore the 1.20 ratio. In pyloric stenosis, the breathing may fall to six per minute, and is of a shallow character, so that the little patient appears to be drugged. With older children, too great zeal in prescribing large doses of alkali in the treatment of acidosis has, in our experience, often resulted in depressed mental and physical states. Tests for acidosis and alkalosis have seemed to us rather unsatisfactory in many respects and we have depended to a large extent on our eyes for diagnosis, and on foods and environment for treatment.

ACID-BASE DISEASES

Whether or not there is a hereditary potentiality to acidosis or to alkalosis or whether these conditions are purely somatic in origin or whether the diseases with which they are connected are hereditary or somatic, is often puzzling.

There are many conditions—diseases if you prefer—with which acidosis is associated. For instance, the acidosis occurring in diabetic mellitus is probably the best-recognized example of a disturbance of acid-base metabolism, being, indeed, consequent on the imperfect oxidation of fats, which leads to an overproduction of the ketone bodies, acetone, aceto-acetic acid, and B-hydroxbutyric acid. Owing to the acid nature of these bodies, the bicarbonate content of the blood is lowered and all the defensive reactions against acidosis are called into play. The excessive excretion of urine with its high content of fixed base diminishes the total content of base in the body, but as long as the reactions are sufficient to cope with the excess of acid substances the acidosis is only in the making. Fortunately we do

not see many cases in children, but treatment should be started with glucose injections to reduce to a minimum the formation of ketones, and continued with a proper proportion of insulin. In a long-drawn-out coma, it may be wise, at times, to administer alkali intravenously.

In treating nephritis in children, the correlation of clinical, biochemical, and pathologic findings in many forms is beset with difficulties. In the main, one may consider two types, the acute hemorrhagic nephritis seen so frequently in children, particularly in older children, and a nephrosis characterized by extensive albuminuria and edema. It is obvious that the kidney functions in three general ways:—first, in the excretion of water,—for the kidney maintains tissue-water at a constant level, since, should dehydration take place, tissue breakdowns would become excessive, acid metabolites would form, and acidosis would be produced. Second, in the excretion of excess salts, both acid and alkaline, which hold the ionic concentration of the plasma and tissues at the normal level. Third, in the production of ammonia as a sparer of fixed base and in the excretion of bicarbonate as an acid sparer.

Physicians are particularly interested in the syndrome of diarrhoea and vomiting, which at times occurs in infants and children, for they are frequently associated with an unbalance in the acid-base equilibrium. In moderate to severe cases, four different processes are seen:—vomiting, diarrhoea, partial or complete inanition, and bacterial infection. Vomiting causes a loss of gastric juice and limits the intake of food for reestablishing it, while diarrhoea leads to a marked loss of water and of alkaline substances. Irritation of the bowel by inflammatory processes may lead to a loss of fluid containing many inorganic fundamentals. Inanition is accompanied by the breakdown of tissue, fat, and protein, since the reserve of carbohydrate, the glycogen in the liver and muscles, soon becomes exhausted in the young child. This causes not only the formation and circulation of the ketoacids resulting from the disturbed fat metabolism, but probably also of other acid bodies which are derived from the protein. Bacterial infection stimulates all catabolic processes, with the consequent disturbance of carbohydrate metabolism and with the formation of excess acid. The net result of all these occurrences is the loss of water, the loss of alkali, but of little acid, and the excessive production of organic acids.

As a young practitioner, we were profoundly impressed by the picture of a case of cyclic vomiting. Today the uncertainty of its etiology has largely disappeared. True, in those periodic attacks

of severe vomiting there is an associated ketonuria (acetonuria). Between attacks, peculiarly, there is often normal health. The stuffing of the child with food, either good or bad, restriction of its play and pleasures, and the disciplinary control of its free body movements in competitive sports in the open air, in our experience, favor these disturbances. Many a spoiled and petted child is prone to such attacks, and it is difficult to determine whether they are hereditary or purely somatic. Rarely does the attack foretell pneumonia, influenza, or other respiratory affection. Since a non-gaseous acidosis is present, dehydration, sunken eyes, retracted abdomen, and well-marked air hunger and constipation may follow, while many ketone bodies may be found in the urine. A passing acidosis may be produced also by the administration of calcium chloride, ammonium chloride, or by a ketonic diet, which is due to a temporary inability of the liver to deal with the excess of ketones. In types of alkalotic, cyclic vomiting, which are, in our experience, extremely uncommon, one notes changes from a non-gaseous alkalosis, in that the carbon dioxide is high, and the chlorine of the blood and urine diminished. While the medical treatment is the administration of large doses of sodium chloride, we prefer to balance metabolism, and when tetany is present, to add to the diet acid-producing substances.

Tetany is associated with rickets and its treatment corresponds with that of rickets. It is accompanied by a fall in both the total and ionic forms of serum calcium. A heightened temperature induces an alkalosis. Infrequently, one may stumble on a case of gastric tetany in association with a stomach dilatation. In any obstruction of the upper part of the small intestine in infants and children and in congenital pyloric stenosis, there is present a well-marked non-gaseous alkalosis.[55]

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CHAPTER 5

THE MECHANISM OF RESISTANCE TO DISEASE

The credit for resistance to disease is often ascribed to foreign immunizing agents, scarcely any consideration being given to the functional capacity of the child's organism for resistance, or to his environment. No intelligent conception of disease resistance in the child can be formulated without due consideration of the nature and causation of disease processes in general. The child's organism, even antenatally, seems to possess certain qualities which bear directly upon the manner in which the organism may be affected by causative disease agents; namely, susceptibility, tolerance, resistance, immunity. In other words, there is a body mechanism which tends to react against these causative agents, though not always successfully. The success of the immunizing agents now in use is based upon the complete unity of the child's organism; their failure is due to disorganization in the body. In former times, men depended solely on their own powers of observation, while their modern confreres have the benefit of perfected test methods. The physician of yesterday based his conclusions on symptomatology. The detection and recognition of the many pathologic changes in the body in disease are equally necessary. Studies in morbid anatomy, infant mortality, histopathology, bacteriology, and protozoology are all forward steps. Also, there is the newly appreciated mode of approach, the accumulation and ordering of facts on symptomatology, pathology, and etiology. These last three form the basis on which disease entities have been determined, and on which a diagnosis in the case of the individual child depends. Nor can one possibly omit from the picture that ancient science, the classification of diseases, or nosology, even though it seems now to have fallen into disfavor.

Morbid anatomy is often misleading, in that it overemphasizes structural changes rather than the functional disturbances which must precede them. This, we think, tends to draw attention to the end rather than to the beginning of the disease process. The development of bacteriology, protozoology, and parasitology has proved beyond question that certain somatic diseases, possibly hereditary, are produced by extrinsic living

agents. There still remain, however, many disease conditions whose cause is not known, and one is forced to adopt etiology, anatomical change, and symptomatology as a heterogeneous basis for classification. This knowledge gives us added courage to stress our ideas of disease prevention and of immunity through balanced metabolism.[1]

The study of the nature of disease resistance is not new; it has engaged the attention of the wisest for generations. Hippocrates used drugs but sparingly and his favorite modes of treatment were rest, fresh air, baths, careful diets, massage, purgation, and soothing draughts of herbs. One of his maxims was, "Natural powers are the healers of disease." Dr. Lindsay says, "Are we likely to be more successful in our struggle with disease by attempting to destroy and evacuate our invisible force, or by aiming at fortifying the patient's natural forces of resistance?"

Nature is constantly seeking a balance, and if she takes away she just as surely gives.

The existence of mental disorders, malformations, hemophilia, color blindness, the anomalies of the eyes, skin, ears, sexual organs, etc., do not necessarily justify us in assuming that the children thus stigmatized are deficient in resistance to other disease forms.[2] Even disease of bacillary or bacterial origin is but a manifestation of a battle fought between the invading organisms and the living body. If the enemy is disarmed, nothing happens, but if he secures a foothold, a disharmony of one or more functions of the host arises, with a definite train of signa and symptoms. When the child's mechanism is balanced it overcomes the activities of the invader, and repair and body recovery take place. A compromise between the parasite and host may come about, and the body may become a "carrier," showing no signs of ill health itself even though the disease is continually present. Our medical journals have often described the epidemics caused by such carriers.

True, there is a racial susceptibility to certain diseases. For example, the negro is immune to yellow fever, the Mongolian to scarlet fever. The lower animals are not exempt from this susceptibility; guinea pigs and mice are highly sensitive to anthrax, rabbits less so, and the rat is almost immune. The white mouse is immune to glanders, the house mouse is somewhat susceptible, and the field mouse highly susceptible. Dissimilar susceptibility in twins of similar strain and race is also observed.

Worthy defenders of the child's delicate body mechanism are the cellular and fluid elements of the blood. The white cells attack and digest the invading parasites, while in serum anti-

bodies, bacteriocidine, agglutinins, lysins, antiagressins, etc., are developed, which destroy, immobilize, clump, and dissolve the enemy organisms. The body cells play an active part in aiding the activities of these defensive forces, and they should be better understood and respected.[3]

TOLERANCE TO CHEMICAL AGENTS

Hypersusceptibility is one of the many problems of immunity that confront one at every corner. Some children may have a marked idiosyncrasy to drugs as well as to foreign proteins, and the analogy between the two is often striking. Hypersusceptibility to a drug may actually be transferred by the blood serum, as is seen occasionally in sensitiveness to veronal, iodoform, and corrosive sublimate. One sees, in a long practice, an amazing susceptibility to strychnin and to coal tar products. No previous sensitization or incubation periods are required, apparently, in these non-antigenic, hypersensitive conditions. Fortunately, very little evidence of susceptibility to morphine, alcohol, arsenic, cocain, hasheesh, nicotin, digitalis, or atropin is encountered in children, except, pathetically, in the underworld.

Modern enthusiastic research has fully elaborated the immunity phenomena in their relation to bacterial diseases, and it is well recognized that microorganisms in general, and even harmless ones, produce a reaction in the sensitive child. By virtue of their protein constitution, all foreign cells are antigenic, but the degree of response depends on the invading agent and particularly on the extent to which it invades the body.

Somatic skin affections in children usually do not produce profound reactions, although, paradoxically, the artificial inoculation of animals with certain agents often leads to antibody formation. Animal parasites in general produce less marked antibody response in children than do bacteria, and their toxins and their reactions do not encourage true immunity.[1] The infectious diseases, on the other hand, usually produce their own antitoxins in large amount if the body conditions are receptive.

INANIMATE FOREIGN PROTEINS

One of the greatest hindrances to immunity is the alteration in the child's organism produced by inanimate foreign proteins. In chemical constitution these proteins are, at times, identical with some of the plant or animal parasites which, when alive,

might produce disease. They differ from the microorganisms which produce infections, in that they are not living, are not able to invade the body, nor to multiply within it. Their effects on the child's body are, therefore, due to accidental contact, to artificial inoculation, or to some alteration which renders their assimilation in unchanged form possible for the gastro-intestinal tract. Again, these protein substances produce disease conditions more frequently on repeated introduction into the body, and in the form known as anaphylaxis, or better, "hyper-susceptibility."

The phenomena which arise in the body following the introduction of the protoplasm of any foreign cell, whether plant or animal, are evidenced by the presence in the blood of antigenistic properties known as antibodies, and any substance capable of producing these antibodies in the animal host is called an "antigen." Proteins are antigens, so are lipoids and the carbohydrates. The latter are not in themselves antigenic, but in uniting with the proteins they become so, provided they are in a colloidal state and soluble in the body fluids. It is believed that many extraordinary reactions in childhood may be traced to this conjunction.

When proteins are hydrolyzed by ferments or changed to poly-peptide through chemical action, or are coagulated, they lose their property of creating antibodies.

The crucible and test tube can not solve everything, and protein chemistry can not give us the key to the riddle regarding antigen and antibody, or to the mysteries of proteins, even of similar relationship. Chemical reagents have also been unable to give us the contrast between animal and vegetable proteins, although clinically every one knows that they are different.[1]

Casein from cow's milk is indistinguishable from that of human milk, yet clinically we are positive that there is a difference, not necessarily due to the chemical constitution of the proteins, but to the physical arrangement of its molecules. In general, proteins of one kind may give rise to specific antibodies in one child but not in another.[3]

IMMUNITY

The sum and substance of resistance to disease, then, is perfect immunity,—a goal quite unattainable biologically. As Herrmann points out, resistance to certain diseases does not necessarily go hand in hand with visible good health. A child may be robust,

even athletically inclined, and still not show a satisfactory resistance to certain infections.[4]

Immunity may be defined as the power of the organism to resist, destroy, and expel from the system the toxic effects of microorganisms and their products, or other foreign proteins; after which the system, in many instances, is not apt to react again to the same poison. This power of the organism to react naturally presupposes susceptibility, for if it were possible to maintain the highest grade of nutritive activity continuously, the effects of any antigen would stimulate the formation of antibodies to such an extent that no profound symptoms of disease could be produced and universal immunity would be established. Immunity means largely the play of the protein molecule, as it does in normal metabolism. The starches, sugars, and fats are directly oxidized into carbon dioxide and water, yielding heat with which to energize the animal economy. Hence the constructive and recuperative work falls entirely upon the protein substances and on the inorganic salts with which they combine. The pure proteins are derived from both animal and vegetable sources. After these proteins are reduced to albuminoses and peptones in the alimentary canal, they are drawn into the protoplasm of the epithelial cells lining this canal.

From the protoplasm of these cells, the proteins are discharged into the entero-hepatic blood stream, but they do not enter the blood as peptones or albuminoses, and the blood contains none of them. Peptones are a highly toxic form of poison. Nature provides some transmuting process in these cells, by isomerism, decomposition, oxidation, reduction, or resynthesis, in which the peptone loses its identity. The protein blends with the blood stream in four distinct forms, among them being hemoglobin and lecithin producers. One of these forms is known to be composed of three distinct subdivisions, the first serum albumins, the second globulins, and the third nucleo-proteins or proteins.

The main function of animal life is to utilize these complex bodies and reduce them to simpler forms. The greatest function of these protein substances is to enter into the composition, construction, maintenance, and repair of all fluids and structures of the animal organism. In the study of metabolism they must be considered highly constructive elements for the maintenance of the nitrogen elements or nitrogen balance, rather than for their caloric value. Naturally the same is true in their relation to immunity. It has been estimated that not less than one hundred and fifty grams of protein must be taken daily in the diet and

absorbed into the circulation and properly utilized if the child is to maintain good health.

The enzymes which go to make up the various digestive ferments become both secretory and excretory products. From the protein substances, in their passage through the liver, there must be produced the bile acids, pigments, and possibly some of the glycogen.

To produce them, the protein substance must undergo oxidation, as well as reduction. The hepatic gland is one of the most important organs in the child's body in its relation to metabolism and its disturbances. Whatever the antigen may be, it must excite the chemical mutations of the protein substances through the activity of the hepatic cells, thus forming the various antibodies, such as the agglutinins, lysins, opsonins, precipitins, the continued activity of which brings about the destruction and liquefaction of the bacteria and their toxins.[5]

There are two distinct forms of immunity, active and passive. In the former type, immunity to a particular disease is achieved by producing in the individual a modified form of it. Passive immunity is obtained by injecting a serum from an individual who has had the disease.[1]

TYPES OF IMMUNITY

The different kinds of immunity are seldom absolute, and all are more or less intimately related. In brief, immunity may be generally classified as "natural, acquired, active, and passive." The natural and passive varieties concern us only in the study of balanced metabolism.

Natural immunity presupposes pathogenic bacteria as normally on the surface of the body, but because of low virulence or invasiveness they do no harm until influences develop which heighten their virulence or in some way reduce the obstacles to invasion. The body possesses defensive mechanisms upon which depend the individual resistance or susceptibility to infectious disease. Many species of animals have different degrees of immunity which may be due in part to variations in the temperature of the animal concerned, to variations in its metabolism, and frequently to a variation in the reaction in the intestinal canal when the normal portal of entry for microorganisms is through this tract.

Acquired immunity, however, is different in character. It has been noted that individuals who had recovered from certain of

the infectious diseases were thereafter not, or only seldom, liable to a recurrence. There are other diseases, less recognized, where an actual immunity exists for longer or shorter periods. Acquired immunity is seen in vaccination against small pox, diphtheria, scarlet fever, and other diseases. Acquired immunity may be conveniently subdivided into, (A) naturally acquired from the introduction of living organisms, such as bacteria, into the body with the subsequent formation of antibodies, or (B) artificially induced through killed microorganisms, as seen in antitoxins, sera, and vaccines.

Active immunity may be induced first through injections of antitoxins, etc., or second through the influence of particular antigens, proteid in character. Passive immunity denotes the formation of antibodies in one animal and their introduction into another. This form of immunity may be understood as:—first, the transmission of the mothers' antibodies to the fetus through the blood of the placenta or also through a virus inactivated in some appropriate way; second, as the injection of the serum of an immunized animal into the body of another suffering from the same disease.

A few words may suffice to illustrate some interesting features of immunity. A calf of a tuberculous cow, taken immediately from its mother and fed from the milk of a non-tuberculous cow, will not develop tuberculosis. Keilty mentions the case of a man who was highly susceptible to ivy poisoning. He fed a cow poison ivy leaves, then drank the milk for some time. By this means he developed an immunity to ivy poison that enabled him to handle the plant without being affected.[6] The Hopi Indians are said to acquire an immunity against the poison of venomous snakes by permitting themselves to be frequently bitten.

IMMUNITY IN HEALTH

In our attempt to depict an immunity established by metabolism and environment, we do not wish to criticize or belittle the scientific methods employed in acquired immunity. This method of stimulating resistance to disease halts, however, with the checking and elimination of the invader. Such immunologic measures cannot bring about a reorganization of the depressed organism, nor can it further its growth, development, and good health. Immunity, to be constructive, must be biologic in character. Not only must the enemy be killed, but the soil which the enemy has devastated must be reconditioned. There is a

potent acquired immunity to disease and there is also a milder natural form that is necessary to preserve health. The establishment of a natural immunity in every day life, therefore, is a subject dear to the physician.

The successful practice of present-day pediatrics relies heavily on empiricism, has always done so, and will continue to do so, to a certain extent; for the child's body is not a mechanical toy, nor is it the product of a purely reagent reaction such as can be developed in the test tube and crucible. It is a living unit, resulting from countless functions and organic activities of subservient units generating every kind of biochemical reaction imaginable and unimaginable. So deeply hidden and secretive, so selective and so circuitous are body reflexes; so individualistic is each child in his reaction to these phenomena; that pure scientific exactness, through mathematical formulae and other methods, in the nutrition and treatment of the child in health and disease is absolutely impossible.

The science of modern acquired immunization was born with the first studies of that mechanism of the body by which it resists the invasion of vegetable and animal parasites. The earliest contributors were Jenner, Pasteur, and Behring. As time passes, science has added the study of the specific reactions of the body to any foreign material, or more explicitly, food stuffs capable of exciting the creation of the so-called antibodies. To this has been further added a study of the various manifestations of the specific reactions found to take place between the introduced foreign material or antigen and its corresponding antibody. Thus we introduce such manifestations as agglutination, precipitation, complement fixation, and anaphylaxis.

It may be true that natural immunity to infections is often not wholly dependent on specific antibodies but on other and provocative unrecognized mechanisms. We are courageous enough to assert that natural immunity induced by good heredity and fortified through proper environment is preferable by far to that induced by laboratory methods, except in emergencies. Balanced metabolism is the source of natural immunity, and, to our way of thinking, at least a minor degree of metabolism balance must take place before sera, vaccines, antitoxins, etc., can be efficacious. Many of the failures of modern immunologic measures are due to an inherited major dysfunction or to a disordered metabolism, or both.

As one grows older, his views on body unity change, for he sees all the organs which nature has provided as useful to the organism, rather than merely objects for medical and surgical

interference. While tonsils, adenoids, and the vermiform appendix are commonly viewed as obstructions dangerous to health, which, in certain instances, they surely are, yet these structures constitute with some others important anti-bacterial weapons and contribute a valuable function in the preservation of the child's health. They should be eliminated only when diseased or hopelessly enlarged. The sub-epithelial lymph glands are some of these insidious natural defenses which strengthen weak organs and contribute to the development of a general systemic immunity. Even many pathologic conditions of these bodies, if not too extensive, may be successfully treated through ordered metabolism.

Nature, when functioning correctly, or if science understandingly comes to her assistance, establishes antibacterial weapons, produced for the most part in certain restricted areas of the child's body, and distributed throughout the blood stream. These antibacterial work shops are the spleen, the bone marrow, and the lymphatic glands. All three are normally concerned in the destruction of waste products such as poisons arising within the body. The first two are concerned with purifying the blood, the last with cleansing the lymph. When bacteria and their toxins, introduced from without, are evident, their removal falls to these very organs, which throw out defenses by way of the blood stream in the form of antitoxins, bacteriolysis, and specially endowed leucocytes.

Where inherited organ dysfunction is of a milder nature, in fact, of the common herd variety, where physical and psychic stimuli are sound in character, where the diet is well ordered and the environment beneficial, therefore where metabolism is well balanced, we find a happy condition of healthy natural immunity. Conversely, if one has to deal with inherited major dysfunction or dysfunctions, vicious environmental factors, and a precarious metabolism, even the administration of extraneous and often foreign substances may not establish the immunity hoped for. Those who have spent years in hospitals, clinics, and other medical institutions cannot fail to verify these statements.

When, as is the case in our large cities and communities, bacteria or their toxins are everywhere and invade the child's organism, they are antagonized under normal conditions by a naturally aroused immunity. It is astonishing what meager defense forces the country child possesses, particularly if reared far from a congested locality, when he is brought into contact with contagion, and how easily he succumbs to disease. While these

sub-epithelial lymph glands, if normal, may defend the child from many infectious diseases originating in the oral cavity and nasopharynx, they may also hold out a protection against most of the pathogenic bacteria in the digestive canal. The healthy child has a remarkable defense against the many microorganisms, both of the throat and intestines. Streptococci, pneumococci, and diphtheroid bacilli, may lie in ambush in the throat, while the colon bacilli swarm in the intestines. Perhaps, as has been estimated, one half of the weight of the feces is contributed by the bulk of these intestinal microorganisms.

The living epithelium of the digestive tract is in itself a formidable barrier; but should bacteria by chance invade, it is still capable of rendering many of them harmless unless obstructed by mechanical or chemical forces. The invasion of sub-epithelial lymph glands by bacteria may be so overwhelming that defense forces of sufficient potency cannot be formed to counteract the pathogenic onslaught.

The helplessness of these structures against the inroads of great masses of pathogenic bacteria, as seen particularly during epidemics, lies in the child's body vulnerability. This vulnerability may be caused by inherited dysfunction, by poorly balanced somatic stimuli, both physical and psychic, or organic dysfunction as a possible result of all these agencies working in conjunction. It is our experience that the excision of the sub-epithelial lymphatic glands is, in many cases, unwarranted and that their presence is of great biologic importance. Therefore, with the balancing of metabolism, more conservative procedures are possible. Even in violent bacterial invasion of the body, especially of the glandular system, immunity might be established through the ordering of metabolism through the rejuvenated lymph glands plus the assistance of natural bacterial antigens. The enucleation of the child's tonsils or their complete excision have been responsible in many cases, we feel, for the susceptibility of many children to infectious diseases, and often for their death. On the other hand, it is true that children who have had their tonsils and adenoids totally removed have, in many instances, recreated an immunity. One often wonders if the child's body, which possesses such great powers of compensation, has not made the immunity losses good through the hypertrophy of the adjacent lymphatic glands, which have largely replaced and supplanted the organs removed.

Zahorsky has recently reported sequelae following the removal of tonsils and adenoids. One hundred and fifty children between

the ages of eight and fifteen were under clinical observation for from six months to five years after the operation. He cites the following pathologic after effects:—

AFTER EFFECTS OF TONSILLECTOMIES

Pathologic Condition	*Cases*
1. Deficient nasal respiration	38
2. Acute otitis media	21
3. Bronchitis	49
4. Bronchiolitis	22
5. Pneumonia	15
6. Rheumatic fever	11
7. Endocarditis	7
8. Chorea	6
9. Diphtheria	3
10. Enlarged cervical glands	15
Cases studied	150

Our own experience has been along similar lines. However, where the adenoids were blocking the naso-pharynx and where the tonsils were hypertrophied, fibrous, and diseased, when they interfered with deglutition, causing mouth breathing, removal was advocated, even when the tonsils were not infected. In children around five years of age it is usual to find hypertrophied adenoid tissue and tonsils enlarged but not infected. In these cases it is best to recommend the removal of the adenoids but not the excision of the tonsils. It is remarkable how often enlarged tonsils, if there is an adequate air supply, together with proper nutrition, will tend to diminish in size. With the most scientific technique and precautions, the removal of tonsils, and even adenoids, is never fully aseptic, and intense and severe complications may often arise. Digby has published a few of these pathogenic sequelae which came under his own observation:—

1. Sapremia with pyrexia
2. Suppurating cervical glands
3. Retropharyngeal abscess
4. Purulent otitis media
5. Endocarditis, usually mitral regurgitation
6. Hemorrhages, both primary and secondary
7. Bronchitis and pneumonia

We believe that, in a number of instances, scarlatina, measles, iphtheria, rheumatic fever, malnutrition, tic, and a change in oice tone have been the fruits of an engendered susceptibility esulting from the improper removal of tonsils or adenoids. ailing to advance a better hypothesis, one might assume that he sub-epithelial collections of lymphoid tissue play an impor-ant role in immunizing the child's organism against pathogenic acteria, in their tendency to involve adjacent localities. This mmunity arises from a phagocytosis, which ingests the bacteria n or near the surface of the covering epithelium. Lymphocytes eave the gland tissue, march to the surface of the epithelium or eyond it into the lumen, engulf the bacteria, and return with hem into the parenchyma; where they are overpowered, de-troyed, or tossed by way of the blood stream to the spleen and one marrow, or to distant parts, to halt specific bacterial in-asions. Bacteriolysis and antitoxins are produced in large amounts.

Natural immunity is of the greatest significance in the young during their maturing years, for in old age the body structures end to atrophy and disappear. The lymphatic bodies are the ones most brutally attacked by alien microorganisms, and those tissues, which are the most severely bludgeoned as a rule, pro-vide the greatest number of antibodies. Does one dispute, for instance, the power of brain emulsions to neutralize tetanus toxin? [7]

NATURAL AND RACIAL IMMUNITY

It is a matter of observation that certain infectious diseases, characteristic of one or more animal species, rarely or never occur in other species. For example, the bubonic plague is not found in cattle, although epidemics of it occur in rodents. We know, too, that fish tuberculosis does not affect warm-blooded animals, nor are anthrax and tetanus found in the cold-blooded species.

Immunity reactions in children are extremely varied. For that matter, it is found that a child apparently enjoys complete im-munity from some diseases, although he is susceptible to others. The writer recalls that during childhood he contracted only one infectious disease, a varicella, even though several contagious disease epidemics swept the community. Some children unques-tionably have an acquired immunity, but this is impossible, as we have said, in the presence of an inherited dysfunction com-bined with a faulty environment. It is only in the well-function-

ing organism that a balanced metabolism will tend to raise immunity control.

Again, in many childhood affections, such as pneumonia, influenza, recurrent fever, and erysipelas, one discovers that there is little evidence of immunity over an appreciable period. In our experience, too, we have seen comparatively few cases of recurring infections, especially among the exanthemata, such as scarlet fever, measles, varicella, and mumps, with practically no recurrence in typhoid fever or anterior poliomyelitis. Obviously there is always the possibility of an incorrect diagnosis.

In a given community, many susceptible children will become infected by certain pathogenic organisms, while a few having a relatively high resistance may possess an immunity by virtue of their genetic constitutions, and will remain unattacked. These few that remain invulnerable have probably inherited immunity from their progenitors, and succeeding generations also will very possibly remain unscathed.

As we see it, when a disease invades a community, all the children are apt to contract it, at least in a very mild form. Some will perish and some will recover, depending no doubt upon the severity of the infection. Those who recover acquire a degree of immunity which will, in part at least, be transmitted to their offspring. These children, even though they contract the disease, will have developed a greater degree of resistance. Crew is of this opinion, and adds that as generation follows generation a specific immunity is established.[3]

A natural racial immunity to certain infectious diseases is lacking among many primitive and nomadic peoples, and when disease is introduced among them it takes a very severe course. When once a somatic immunity is established, a natural immunity follows, and the invading disease takes a much less virulent course; indicating, we believe, the influence of certain changed constitutional factors which possibly might be considered hereditary.[8] In other words, it may be said that natural racial immunity to specific diseases exists only in those animals, humans, and plants which have lived for several generations in contact with the disease-producing parasite. The status of the Polish Jews of the Ghetto in relation to tuberculosis and certain other infections is an illustration in point.

It should be emphasized, then, that resistance to disease is inherited, at least in part; but naturally the child cannot inherit something that the parent did not possess. It seems probable that an acquired immunity to certain substances is localized in particular cells, and that this quality of immunity can be trans-

rred to succeeding somatic cell generations. Although the effect f two disease substances on the cells is apparently the same, he mechanism through which immunity is produced differs in he case of each substance. Can we not logically conclude that, ust as in the case of germ cells, an effect produced through an xternal agency can be transmitted to later generations by the omatic cells?

Allowing that immunity, or at least potential immunity, may e inherited, these tendencies cannot long remain in storage if omatic difficulties interfere. One cannot empty the glass and ssume that some of the contents have remained. A faulty diet, mproper digestion, mental states of anger, fear, worry, nervous train, etc., may either unbalance the cell or leave it injured, nsatisfied, or depressed, thereby exposing it to toxins and other acterial products, which then enter into affinities and combiations. Other environmental considerations come into the picure of natural immunity. Age has already been mentioned, and here are other differences, due in part to variable opportunities or infection, differences in resistance due to miserable hygienic surroundings, to economic cloud-bursts, to lack of personal hygiene, to poor ventilation, bad sanitation, or to over-exertion or exposure.[9]

CONGENITAL ACQUIRED IMMUNITY

This form of immunity, essentially passive, precedes and tends to establish the immunity storage of the new-born infant. It may be transferred from the mother's milk or from substances delivered through the fetal blood from the mother's organism. These substances gradually disappear, and unless they are restored through the soma by proper nutrition and surroundings, the infant becomes more and more susceptible to disease. Slight differences in immunity-storage and in the chemical structure or composition of the cells or tissues of the body may or may not resist the combining effects of the various antagonizing bacterial products.

Since immunity is in general both natural and acquired, the basis of natural immunity, whether of species, race, or individual, is heredity. While it seems improbable that immunity can be transmitted by the germ plasm, yet some form of it, a potentiality, shall we say, must be bound up with this sound transmitted substance. The greater possibility of immunity-transmission to the child, however, is that form which the understanding better comprehends, the acquired form in utero.[6] The possi-

bility of an active intra-uterine immunization of the fetus must always be considered. This may occur through the passage of the living infectious agent or of its products from the mother to the fetus.

A distinction must be made, however, between this condition and a passive immunization by means of the mother's antibodies through the placenta or through her milk to the young. In diseases which are supposed to be due to ultra-microscopic organisms, the virus, it seems to us, can not infrequently pass through the placenta and affect the fetus in utero. Where immune offspring are born from mothers who have passed through a certain disease during pregnancy, caution must be exercised against accepting this as a true passive transmission of immunity from the mother. Experiments would seem to indicate that most bacteria do not pass the intact placenta except under extraordinary conditions, and the fetus of a very young animal possesses only feeble reactive powers of antibody production. When the mother shows a high degree of immunity at the time of the birth of her offspring, some of this immunity, in other words her antibodies, may be passively transmitted to her young. This occurs through the placenta before birth or through the milk afterward. The passive transmission of antibodies to the offspring is practically established beyond a doubt. This seems to hold for almost all classes of infectious organisms where a true active immunity takes place in the mother's body.[10]

There may arise a curious condition which, from time to time, warrants one's attention. Some children, even those suffering from general body weaknesses, appear to be unsusceptible to many epidemic diseases. Shall we assume that humans, in the flight of centuries, may become accustomed to certain inherited pathologic states? Certainly we do know that when the functional activity of one organ is slightly impaired its neighbors may assume its work. As far as we know, a morbid condition may exist in the body of an apparently healthy individual, as Herrmann has pointed out, for the functional capacity of an immune child in no way differs from that of a diseased one.

It must not be forgotten that microorganisms have a disturbing way of taking effect suddenly, often intensely, sometimes only transiently, in young children, in such a manner as to render them unable to accustom themselves to their unfavorable environment. In spite of the best of inherited constitutions and environmental conditions, complete immunity to disease in children is still wistfully sought after.[2]

THE CELL AND IMMUNITY

In seeking the establishment of immunity, we are merely following along the same old path to balanced metabolism and being rebuffed by the same old hazard, the biologic cell. Blood immunity is impossible without cell immunity. Every activity which goes on in the child's body dates from the cell; assimilation, metabolism, and again, the formation of antibodies. As Ehrlich once said, the microscope has done much for us and is doing much now, but even the microscope has its limitations. However, the cell's activities are not visible to us by means of the microscope, but the time has come when, through biophysiologic chemistry, we may gain some knowledge of its processes, at least in some of its important functions. With the improved laboratory equipment and technique of today, further knowledge is close at hand. Colloidal chemistry, too, has assumed an important role.

The child's body normally provides defensive means to protect it from the danger of being overrun by devastating forces. When protective material is injected and no defense against the disease is brought about, we impulsively brand the treatment a failure. Undeniably a starved cell cannot assimilate a powerful foreign protein. It seems difficult to believe that experimental immunity reactions as demonstrated in a test tube, such as colloidal chemicologic reactions of the serum and physico-chemicologic reactions of the blood cells, have any close connection with the purely structural chemicologic laws of hypothetical and unknown substances of the serum. The endothelial cells are the youngest, most active, most important and many-sided cells of the body. It is not to be thought that the cell immediately after the taking up of pigment or a bacterium dies, for if it did immunity would be impossible. After all, this immunity problem is simply a metabolic problem. It is quite possible that toxins stimulate the protoplasm to form defensive bodies. We cannot conceive of immunity through substances like food alone, but through that part of the food which the cell can utilize. Nor can we wholly understand how antitoxins, antivaccines, and antisera can effectually accomplish what we expect, when the cell is starved and abused.[11]

Another barrier confronts us. Acquired diseases of any sort which become somatic in character are rarely caused by a single micro-organism. Most disease conditions are caused by a mixture of micro-organic strains of varying potency and amount, or by

the many associated strains of a general class of bacteria. A simultaneous production in a single individual of antibodies against each of a number of invading strains of bacteria, or by bacterial antigens through non-specific immunization, would be a poetic rhapsody, could it be brought about. Indeed, the employment of prophylactic immunization against disease and the use of immune sera to combat specific infection would be greatly facilitated if an adequate antibody production combined with a wide polyvalency could be assured. The objections to such immunization might be based on the theory that the simultaneous treatment with a number of antigens does not produce as great an antibody response to each antigen as can be obtained with single strains.

Undoubtedly it is true that in the majority of cases attempts at multiple immunization fail to produce adequate antibody response. We are strongly of the opinion that a well ordered cell metabolism can in itself produce such necessary immunization through the production of special antibodies against each and every strain of micro-organism found within the body. A polyvalent antigen, however, might render useful aid in emergencies. Failure to produce such an antibody response, or antibodies from either single or multiple antigens through non-specific immunization or from cell metabolism, would seem to be due to (a) the failure of the immunity mechanism to respond to (b) factors influencing the general condition of the child—causes, in other words, which create instability of cell metabolism through faulty heredity and environment.

As a rule, a child in poor condition is not amenable to antibody production. Therefore it necessarily follows that the introduction of such substances as sera, vaccines, etc., may profoundly affect the general condition, or else the cell metabolism may be so depressed that the cell cannot establish the necessary valent antibodies. All of which means that whether the antigen is introduced or whether antibodies are formed from cell metabolism, the formation of such antibodies must acquire a field for their production. It must not be forgotten that in immunization against bacteria or their products, and in the introduction of large amounts of bacterial emulsion, the specific antigenic portion is necessarily accompanied by a large amount of non-specific substance which may well affect the child's general health.

One can well assume that the cell's highly graded activities through nutrition and environment would have no such evil influences. Just such a factor as the introduction of these non-

specific substances would probably in itself cause the failure to produce adequate polyvalent immunization, which, other things being equal, the high functioning cell would be able to do.[12]

THE DUCTLESS GLANDS

The ductless glands of children are frequently involved during infections and intoxications, and, as they are of so much importance in mental and physical growth and development, any specific or polyvalent antigen against the onslaught of disease would be gladly welcomed. The thyroid, adrenals, hypophysis, ovary, and testicle are often diseased in the course of a great variety of toxic infectious states; as, for example those following tuberculosis, syphilis, typhoid fever, influenza, scarlet fever, small pox, diphtheria, mumps, tetanus, and a host of others, including the intoxications of mineral and other poisons, not forgetting rheumatic conditions and infections of the stomach and intestines. Constantly there arises the perturbing question, "What influence on immunity do the hormones specifically exert?" If the normal metabolism of the cell aids in the development and functioning power of the endocrine glands, do these latter conversely repay the cells by stimulating them to renewed activity and to rejuvenated ability to produce antibodies?[15]

IMMUNOLOGIC REACTIONS

Specifically then, what are antibodies? They are spoken of glibly, but in reality their mode of formation is unknown and they are recognized mainly through their activities. Bacterial and other toxins, as well as proteins generally, when introduced in suitable animals, have the power to cause the formation of specific forms called antibodies. Substances having this property are called antigens. Antibodies appear in the blood following the action of antigens and they are probably formed in the blood-making organs. The living organism defends itself against the chemical attacks of its enemies and thus is able to survive in an environment seething with them. The action involved is chemical in character, for the biologic reagents involved are substances endowed with active chemical properties; the products of the chemical activity of the tissues of the body. Indeed the chemistry of immunity is practically the same as that of the enzymes.[14]

Many diseases stimulate the body to produce antibodies, which are capable, first, of destroying foreign organisms, and, second,

of neutralizing those poisons which they produce. The disease-resisting property of antibodies is merely the special and useful application of a general power that living protoplasm has of getting rid of foreign proteins. These foreign proteins, however, rarely come in contact with living cells of higher animals, because all proteins taken in are digested into their constituent amino-acids before being absorbed into the body fluids. Indeed it is characteristic of the cells of highly organized animals that when foreign proteins come into contact with them they react by producing antibodies. The antibodies precipitate the protein or dispose of it in some other way. The important feature of antibodies is that there is a particular sort for each kind of protein, and when the cells of the body react to the presence of a foreign protein, the antibodies they produce are the specific ones by which that protein is disposed of.[15]

After immunization with a given antigen, whether artificially administered or created by the natural processes of infection, the blood of the child and possibly all his fixed tissues as well tend to exhibit the capacity to react in some way to the antigen, in a manner qualitatively different or in a degree quantitatively greater than previously. We attribute this altered reactive ability to the presence of antibodies, despite the fact that at the present time we have no absolute knowledge as to what these bodies may be, neither do we know whether they exist as material objects. In time, of course, this point may be cleared up, but at present we recognize them as we do the enzymes, by what they do rather than by our understanding of just what they are. We designate these antibodies as precipitins, agglutinins, antitoxins, complement fixation antibodies, opsonins, anaphylactins, etc., according to their character and the work they perform. Of late, there has been growing feeling of doubt concerning a considerable variety of these antibodies. One notes too, that the suspicion of their presence has in no case led to definite diagnostic conclusions.

Since these antibodies are constituents of the blood, does it not seem reasonable to suggest that they are formed in the same place as many other elements in the blood, namely, in the bone marrow and in the lymphoid structures. At the same time, there is considerable reason to believe that antibody formation may be a widespread cellular function, possibly participated in by many or by all the different kinds of cells, specific or otherwise, in the body. Zilva believes that the capacity of the body to produce antibodies is but little affected by certain diets or by a deficiency in accessary food factors, including vitamins and

arious salts, except that possibly phosphorus deficiency reduces ntibody formation. With this conclusion, however, we cannot gree. Indeed, various inorganic salts appear to have a stimuating effect on and serve to maintain the antibody content of he blood at a high level; much as these salts, we believe, stimuate growth impulse and development through metabolism. It nay be possible that the endothelial cells throughout the body re particularly concerned in their manufacture.

The mode of transmission has been long in doubt. Svedberg as lately separated serum globulin, one of the most important lood proteins, into three distinct components, alpha, beta, and amma. He finds that the gamma globulin carries the antiodies.[16]

As to the exact formation of antibodies proper, many of us are t sea, for the specific "receptor hypothesis" is not easily undertood or interpreted. Manwaring speaks of this situation in the ollowing paragraph with no mincing of words, "Practically the nly complete and consistent theory as to the origin and nature of the immunologic antibodies is the theory based on the specific eceptor hypothesis. Physiologic data collected in our laboratory during recent years are sufficient, to my mind, to prove this heory wholly untenable. I believe that the wide acceptance of he specific receptor hypothesis by clinicians and practical serologists constitutes today our most serious handicap to immunologic progress, and that the theory should be replaced by concepts more nearly in accord with accepted facts of biochemistry."[17]

PRACTICAL TESTS OF IMMUNITY

"The proof of the pudding is in the eating," and the practical proof of immunity is not necessarily knowing just what it is, but just what it does when circumstances are right and metabolism is in order. Modern immunology has advanced a good step forward in the discovery of practical tests for immunity, present or absent. A mother who has had a disease has acquired an immunity, has antibodies in her blood which are eventually conveyed to the fetus.[4] The infant, therefore, has a passive immunity which lasts for a few months and gradually disappears. Apparently what the infant inherits is not an actual immunity, but an ability to manufacture antibodies from antibodies; in other words an active immunity.

This is demonstrated in the "Schick test" for diphtheria. If the mother has acquired an immunity, the child reacts negatively. This test is valuable in the first few months of life, for

as the infant grows older this passive immunity is generally lost and the Schick test reaction becomes positive. The writer is of the opinion that a certain percent of all children cannot seemingly develop these immune bodies from antibodies received at least in sufficient amounts to establish consequent immunity in spite of the infection of a toxin-antitoxin mixture.

Zingher has shown that when the youngest child of a family shows a negative reaction to the Schick test, the older children also follow in line. It is probable, according to Herrmann, that the ability to develop antitoxin within the infant's body has some relation to dominance in heredity, and the ability appears to be a distinct one for each disease.

Within the bodies of those children who apparently are immune to many diseases, there must presumably be harbored many varieties of antitoxins. The normal intact placenta in many cases acts as a biologic filter to the introduction of injurious substances into the fetal circulation, for, with few exceptions, the diseases of the mother are not transmitted to the developing ovum. A mother, adds Herrmann, suffering from tuberculosis or cancer, may give birth to a comparatively healthy child.[4]

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CHAPTER 6

DIAGNOSIS

THE INSTANTANEOUS recognition of physical and mental organic irregularities is usually the key to a more detailed diagnosis. Mental calculations flash through the pediatrician's mind and disease characteristics are instinctively and systematically catalogued. He distinguishes gross from minor dysfunctions, whether of body or mind, and the diagnosis, subsequent treatment, and prognosis all make their immediate and vivid impressions. He recognizes those conditions which should have surgical attention and those which may be treated medically. He sees the lesions which can be remedied primarily by an improved metabolism and a better environment, as well as those which cannot.

Alois Monti of Vienna, the master pediatrician, was in the habit of advising his assistants to make a fleeting diagnostic survey of their little patients as they entered the consultation chambers. This observation may induce a favorable psychic effect on the child and thereby lessen to a marked degree his timidity and fear in the subsequent examination. It is most essential for the young physician to acquaint himself with the surface signs of disease and health. No greater error can be made than to consider that the illnesses of infants and children are modifications of those suffered by adults. They are not, and the difference may be accounted for largely by the immaturity of the organs.

The examiner must pay particular attention to the apparent cause of the dysfunction, whether it is hereditary or somatic in character, or whether it seems related to both. All diagnoses must be individual, not general. However, certain "lead-in" points may be generalized in accordance with our own interpretation of them.

VISIBLE SIGNS

As the child is brought into the consultation room, the waiting physician notes certain obvious physical and mental peculiarities. On closer observation, he looks for physical lesions which will require remedial treatment.

Knowing the head to be normally about fourteen inches in

circumference at birth, the observer will take particular note of the present size. The head may be large and spherical, the fontanelles patulous, the sutures wide, and the face small. There may be evidence of a peculiar lethargy, of possible spasticities, a heaviness in raising the eyelids, and an occasional sharp cry. A chronic, internal, hereditary hydrocephalus may be considered. The head may appear quadrilateral in profile, the forehead being high, square, and prominent. The cranium viewed from above may appear elongated, large, and square, with the vertex flattened. Normally the anterior fontanelle is patulous until the third or fourth year, but certain additional areas of softening may be indicated, together with a peculiar undulating crispness of the occipital bones. Head sweating may be present. Infrequently, as compared with former times, the clinician notes a head whose sutures are depressed and surrounded by parietal bosses, conditions which particularly affect the frontal prominences. The head may have a peculiar shape, such as the hourglass or hot cross bun types. Craniotabes is usually encountered in these instances.

A large, flat-topped head with the anterior fontanelle patulous, a broad, flat face with a negroid nose, a low forehead, eyes far apart, a vacant stare, an open mouth, a protruding tongue, scanty and coarse hair, delayed dentition, a short body with flat chest and pot belly, all point to cretinism. Perhaps the pediatrician will see a head with a large vault, a depression of the nose, which signify prognathism or achrondroplasia; or he may see a microcephalic idiot with a small head, a receding forehead, and flat occiput, the apex being at the crown. Less frequently there appear cases of infantile cerebral paralysis, mongolism, acromegaly, perhaps osteitis deformans, and other even less readily recognized types.

The abdomen may be enlarged. Perhaps as the child extends its arms and legs, epiphyseal enlargements of the wrists and ankles may be seen. The physician will recognize a pigeon breast and the rachitic rosary, bowed spine, knock knees, or bow legs; and he may hear the characteristic cry that denotes painful joints. Snuffles, a roseola on the body, desquamating soles and palms, ulcerations at the corners of the mouth, and various peculiar bone abnormalities may be noted. When the lips are drawn back, Hutchinson's teeth may be observed. With the eyes opened wide, a keratitis, an iritis, or a choroiditis may be seen, denoting congenital syphilis.

Should the anterior fontanelle be patulous and somewhat longer than usual, rickets may be suspected. If it should be found

open in the tenth year, cretinism is practically a certainty. How-ever, latent congenital syphilis should not be disregarded. A reasonably delayed closing may, on the other hand, indicat malnutrition. The patulous condition persists in a chondro plasia, chronic primary hydrocephalus, and mongolism. In case of acute fever, the anterior fontanelle bulges and pulsates with each heart beat. In chronic primary hydrocephalus, in cerebro spinal meningitis, and in tuberculous meningitis the fontanell is both tense and bulging. This bulging is seen, too, in cases c meningeal hemorrhage in infants, especially if the bleeding i abundant and the sutures separated, and also in the infrequen cerebral tumors of infancy.

The sunken fontanelle is usually incident to the wasting di eases and is particularly noted in excessive diarrhoeas. Th physician is reminded of the premature closure of the fontanelle in microcephalus and in oxycephaly. A delay may, however, b seen in prematurity or in the urethral tumors of infants.

Closer observation may show a moderate hematoma, or smal furuncles of the scalp, perhaps a mastoiditis. Possibly, in th newborn, the physician may encounter a caput succedaneum, a cephalematoma or a cephalocela, a thrombosis of the lateral sinus a small cavernous angioma, papilloma, a diffuse celluitis, a tuberculous osteitis, and many lesser conditions. There may b present a peculiar rolling of the head, which may signify a chronic internal hydrocephalus, a nodding spasm, Friedreich' ataxia, or a mild neurosis. Spasmodic movements of the hea are noted, such as habit spasm and head hanging, in chorea an epileptic seisures. A slight forward bending of the head ma disclose a fracture or dislocation of the upper cervical vertebrae or perhaps tuberculosis of these vertebrae. The head may b turned to one side, as in torticollis, cerebral hemorrhage, squint or oculomotor paralysis. The head may be found to be retracted denoting perhaps cerebrospinal meningitis, tuberculous menin gitis, retropharyngeal abscess, tetanus, meningism, a possibl cerebellar hemorrhage, or a thrombosis of the superior longi tudinal sinus.

A more careful scrutiny may disclose enlargement of the smal veins of the head, which may indicate congenital hydrocephalus rickets, congenital syphilis, or a possible tuberculous meningitis The hair may be absent or thin, with much dandruff present, con ditions sometimes resulting from congenital syphilis, cretinism anemia, or mongolian idiocy. Even bald spots may appear, du to rickets, scars, erysipelas, impetigo contagiosa, and rarely fro favus. Certain affections of the scalp may be found. Even toda

in Europe and in this country as well, one sees eczema, tinea tonsurans, pediculosis capitis, impetigo, an occasional alopecia, syphilis of the scalp, or small sebaceous cysts.

The keen observer will be able to note a possible syphilitic alopecia or eczema in the ragged appearance of the eyebrows. If he is sympathetic he cannot fail to see signs of pain in the face of the child suffering from dental caries, maxillary sinusitis, or an abscess.

In older children such pain manifestations may be the result of trigeminal neuralgia or lesions of the tongue which have occurred at play. A distinct pallor of the face is seen in chronic pulmonary tuberculosis, in mitral regurgitation, arthritis, acute nephritis, and even in constipation. The same pallor will be noted in empyema, scurvy, colitis, and duodenal catarrh. A sudden pallor may be emotional in nature, denoting fear, disgust, or shock; or, it may result from acute hemorrhage, chills, bronchitis, and especially from petit mal. Natural flushing of the face is rarely seen except after exercise, a heavy meal, or a prolonged sun bath.

When the pediatrician observes a sardonic grin on the face of the little patient, he will immediately consider the possibility of lockjaw, acute general peritonitis, scar contractions, facial nerve spasms, and even hysteria. A twitching face is often seen in chorea, habit spasm, the reflex spasm of epilepsy, facial paralysis, and occasionally in meningitis and in a rare type of degenerative psychosis found in young girls.

A general swelling of the face may denote measles, sunburn, eczema, pertussis, empyema, scurvy, serum sickness, mumps, and perhaps tuberculosis of the bronchial glands. Thickened features may suggest cretinism, scleroderma neonatorum; and inequality in the two sides of the face may denote a facial paralysis. Closer scrutiny may disclose abscesses, furuncles, an alveolar abscess, the swelling of vermin bites and stings, and, in rare cases, erysipelas, mumps, urticaria, blackheads, angioneurotic edema, or possibly anthrax and scurvy.

Naturally one finds many skin affections on the face, such as freckles, impetigo contagiosa, eczema, herpes pimples, nevus, tinea, seborrhoea oleosa in undernourished children, and, in rare instances, erythema multiformis.

Ocular conditions may be seen, such as a mild or severe ptosis from facial paralysis or from a cerebral tumor, meningitis, or progressive muscular atrophy. The ptosis may be congenital. Occasionally there is found an ecchymosis of the eyelids in pertussis, infantile scurvy, epilepsy, purpura hemorrhagica, and

hemophilia; while a puffiness is observed in measles, pertussis, infantile scurvy, acute coryza, varicella, and trachoma. There may also be an abscess of the lid, or a foreign body under it.

In the poorer quarters of New York the writer has discovered cases of blepharitis, measles, seborrhoea, eczema, herpes, urticaria, and rarely, syphilitic tarsitis, a condition in which the eyelids are badly encrusted. In malnourished, nervous children, forced to work beyond their strength, one finds a winking of the eyelids resulting from conjunctivitis, a tic distinct from that seen in habit chorea, or a reflex from intestinal worms. One may see subconjunctival hemorrhage from a blow in the eye, from pertussis, scurvy, or from lacrimation caused by acute catarrhal conjunctivitis, measles, and enlarged adenoid growth. In petit mal there is frequently a motionless eyeball. Squint is frequently seen in the consultation room, but when it results from tubercular meningitis, cerebral tumor, or post-diphtheritic paralysis it is observed first, as a rule, at the bedside. Nystagmus is often seen, while spasmus nutans, chorea, meningitis, and ophthalmia neonatorum appear in centres of unemployment and poverty.

Occasionally there may be observed in connection with infantile scurvy an ecchymosis of the orbit, which results in prominence of the eyeball; while photophobia, by no means a rare condition, is encountered in eye strain, conjunctivitis, measles, coryza, and influenza, and less often in cerebrospinal meningitis, pertussis, varicella, anemia, stomach upsets, or constipation.

It is advisable, moreover, for the physician to have a diagnostic knowledge of the common conditions associated with the sense organs. Pain in the ear indicates a possible acute otitis media, acute mastoiditis, or even a furuncle or foreign body in the external auditory canal. Obviously, it may come from mumps, tooth caries, catarrh of the eustachian tube, impacted cerumen, or adenoids. Sometimes there is a characteristic discharge from the aural canal. An acute purulent otitis media is easily recognized by the smell and color of the discharge.

Pain in the nose, of which so many children complain, is usually discovered to be from an acute rhinitis, a foreign body lodged in the nares, or from a furuncle. Redness of the nose follows a head cold, a fit of crying, or a possible obstruction. Sometimes there is a coexistent nasal diphtheria and an associated watery, muco-purulent, or purulent discharge. After a drink of water there may be a regurgitation of the fluid through the nose from a post diphtheretic paralysis or even from a cleft palate.

The lips, aside from showing a possible trauma or swelling

from insect bites, etc., may carry a nevus, wart, or occasionally herpes simplex. Hare lips and cleft palates are reminders of a damaged heritage. Within the mouth one may find a stomatitis aphthosa, occasionally an ulceration, and in spite of improved conditions in these days, pellagra. A foul breath may accompany adenoids, dental caries, stomatitis, dyspepsia, empyema, measles, scarlet fever, scurvy, and nasal obstruction, or there may be a foreign body in the pharynx or larynx.

While examining the mouth of the infant, the hand may become sprinkled with saliva from the drool caused by fear or irritation. An identical condition in older children may be caused by stomatitis, facial paralysis, adenoids, mumps, dental abscesses, scurvy, sprue, jagged teeth, or worms. Dryness of the mouth is noted in nasal obstruction and thrush. At times one may note bleeding from the mouth in gingivitis, from small ulcerations, and from hemophilia. If the child's mouth remains open, one thinks of adenoids, nasal obstruction, idiocy, cretinism, or perhaps a retropharyngeal abscess. Small ulcerations or white patches in the mouth indicate stomatitis aphthosa, thrush, varicella, diphtheria, influenza, or Koplik's spots. If inadvertently the tongue depressor touches the gum there may be pain and bleeding brought about by simple ulcerations, catarrhal gingivitis, stomatitis, scurvy, measles, hemophilia, cleft palate, or beri beri.

A sore tongue may be caused by a traumatic ulcer from sharp teeth, by a diffuse glossitis, or occasionally by eczema. A coated tongue is extremely common, and may result from constipation, simple acute gastritis, catarrhal stomatitis, acute tonsilitis, thrush, rheumatic fever, scarlet fever, measles, pneumonia, jaundice, or scurvy. A swollen tongue is usually seen in cretinism, acromegaly, mongolian idiocy, food poisoning, trauma, burns, and scurvy. Ulcerations of the tongue are seen in dentition, herpes, pertussis, and diphtheria.

While pain in the teeth is referred to the dentist, we are interested in delayed dentition as seen in rickets, cretinism, Little's disease, and infantile scurvy. If the mother says that the child grinds his teeth, we consider the possibility of round worms, chorea, or perhaps a touch of rheumatism.

Pain in the throat is a common complaint and may come from acute catarrhal pharyngitis, acute tonsillitis, scarlet fever, diphtheria, edema of the glottis, or retropharyngeal abscess. Common, also, is a tickling sensation, which may arise from a simple acute rhinitis, an acute catarrhal pharyngitis, scarlet fever, measles, influenza, and diphtheria. Obviously, swollen tonsils

occur in acute tonsillitis, also in measles, mumps, acute pharyngitis, scarlet fever, and many other diseases. An ulceration of the tonsils sometimes accompanies diphtheria and scarlet fever. White or gray patches on the tonsils may signal the presence of diphtheria, scarlet fever, measles, pertussis, thrush, and adenoids. A retropharyngeal abscess may be detected. One very common occurrence is an accumulation of mucus at the back of the pharynx, resulting from an acute naso-pharyngitis, nasal obstruction, enlarged uvula, acute catarrhal laryngitis, sometimes from measles and scarlet fever, and often from malnutrition. Paralysis of the soft palate is seen in post-diphtheritic paralysis. Painful swallowing may coexist with acute catarrhal laryngitis, scarlet fever, and acute catarrhal pharyngitis. Of passing interest is a bifid uvula, an elongated uvula, and acute uvulitis.

Pain in the neck may be ascribed to an acute catarrhal laryngitis, an edema, a foreign body, or pressure of the glands in that neighborhood, acute tonsillitis, peritonsillar abscess, and occasionally to tuberculosis of the cervical vertebra.

Hoarseness develops from an acute catarrhal, tubercular, or spasmodic laryngitis, and, in older girls, from goitre. A glance at the neck may disclose a swelling, which in childhood results usually from enlarged lymph glands anteriorly located, or from mumps. Less frequently the condition may arise from cellulitis, a bronchial cyst, cretinism, interstitial emphysema, and, as observed by the writer, from anthrax. These enlarged lymph glands are very common in childhood and may arise during attacks of acute tonsillitis, tooth infection, acute pharyngitis, diphtheria, scarlet fever, measles, catarrhal stomatitis, eczema, impetigo contagiosa, seborrhoea, and pediculosis capitis. A moderate enlargement of the thyroid frequently appears near puberty from an unbalanced metabolism. Infrequently the clinician encounters children with torticollis or wry neck, sometimes congenital and sometimes spasmodic, which may date from a rheumatic diathesis, cervical adenitis, or from worms.[1]

EXAMINATION ON THE TABLE

After the visual scrutiny of the head and neck, the clothing is removed and the child inspected naked on the examining table. The child's body is a composite entity, for two children are never wholly similar in appearance. To the experienced pediatrician, the child's body has a more or less standardized appearance as to form and contour, according to age, race, nutrition, growth

impulse, and other factors. Naturally one must know the recognized normal body characteristics before the abnormal features can be recognized, for while there are individual and racial propensities, the body in general is the same in any group of individuals or races.

In the fat or lean, the tall or short, or in individuals of particular inherited states, a glance informs us of natural or unnatural depressions, elevations, ridges, twitchings, pulsations, tumors, bulgings, and furrows. In the work of examination the line of vision had best be oblique. The light used should be considered from the view point of casting shadows that will intensify surface physical changes. Diffused daylight is best for the purpose. Direct sunlight and artificial light are to be avoided when possible. The naked body of the child reveals mobile lines and shadows which move with respiration. With keen eyesight, changes of level can be seen as one organ overlaps another at the margin. The left lung overlaps the heart; the liver, the intestines and stomach; the transverse colon overlaps the small intestine, and some of the coils of the intestine encroach upon other coils.

With respiration, the endothoracic, and intraabdominal pressures are alternately increased or depressed, and these changes of pressure cause the viscera to move. This is seen distinctly in malnutrition, particularly in those putrid, gastro-intestinal disturbances seen in the tropics. The skin and muscles oppose the viscera underneath and tend to mold themselves upon the organs, provided the skin and muscles lie relaxed upon them, for if they are taut and rigid these conditions are not possible.

It may have been the experience of most physicians that the visual inspection of the lungs, heart, spleen, and kidneys is best accomplished with the patient in the erect position. The liver, stomach, intestines, and urinary bladder are best observed in a recumbent posture, with the eyes of the examiner on a level with the anterior body surface. Standing in front of the little patient, now erect, one may see the margin of the apex of the lungs as it strikes the skin at the end of inspiration and recedes with expiration. In this position, too, but a little to the patient's right side, one is often able to see the left margin of the heart and its rotation in systolic contraction upon its longitudinal axis from right to left. The lower margin of the liver, as it normally extends from about one half to three quarters of an inch below the free border of the ribs, produces a marked change of level upon the skin. There is a slight convexity below the margin of the ribs on the right side which is not present on the left. The

upper margin of the liver, or rather that part of it which opposes the thoracic wall, can often be seen. Normally only the greater curvature of the stomach is observable.

At times, at the height of inspiration, one may see the outlines of the kidneys and spleen when they strike the abdominal wall. With the child prone upon his face, they recede with expiration. The better one knows the normal body, the more readily can he interpret abnormal changes. The lung's apex may appear to bulge slightly, thereby concealing an infiltration or retraction, or possibly denoting a cavity. A distinct and sharply outlined clavicle may portend this retraction. In rachitic, as well as undernourished children, an enlarged liver may protrude, and the skin over this enlargement is more tightly drawn than over surrounding areas.

In older children, a simple jaundice may establish a slight enlargement of the gall bladder. The common duct is best recognized by the fingers as a faint tubular swelling running obliquely downward and inward. In a good light, the duodenum is seen as a tubular swelling, and a series of contractions may indicate pylorospasm.

With the child's clothing removed, the various body deformities which are the results of diseased organs can be seen. Among these conditions are adenoids, hypertrophied tonsils, rickets, adherent pleurae, healed empyema, scurvy, pertussis, and an enlarged thymus. When the pediatrician sees a bulging or an obliteration of the intercostal spaces, instinctively he considers pleurisy with effusion, empyema, or even a hydrothorax; while, on the other hand, a retraction is fairly rare. A slight pressure on the child's shoulder may elicit pain, and a fracture of the upper extremity of the humerus may be disclosed. If there is a history of rheumatism, there may be present a brachial neuritis, an acute arthritis, a synovitis, a swelling of the shoulder joint, or possibly an old dislocation or fracture.

Especially in badly nourished children, a swelling in either or both axillae may indicate enlarged lymph glands, an acute abscess, simple or tuberculous in character, lipomata, a tuberculous adenitis, scabies, intertrigo, eczema, tinea, or pediculosis. The various forms of paralysis and atrophy do not rightly belong in this discussion, with the possible exception of acute anterior poliomyelitis, Duchenne's and Erb's paralysis, and progressive muscular atrophy.

Gently lifting the arm may cause pain, resulting from a sprained elbow, acute synovitis, a dislocation or fracture, acute arthritis, major or minor rheumatic conditions, tubercular joints, or even

hemophilia. The light pressure of the clinician's fingers on the hand of the patient may show a swelling from a sprain or fracture, rickets, rheumatism, gonorrhoeal arthritis, tuberculosis, and, rarely though occasionally, from a separation of the lower epiphysis of the radius. Moreover, deformities of the hand are frequently met with in cretinism, idiocy, tetany, progressive muscular atrophy, achrondroplasia, and at times in acute poliomyelitis. The skin affections of the forearms and hands are substantially those of the axillae, with occasional warts and erythema multiformis, eczema tinea, and, in factory communities, callouses and evidences of pellagra on the palms and soles. Clubbed fingers should not be overlooked, as they may appear in congenital heart disease, bronchiectasis, empyema, and phthisis.

The skin of the chest is the seat of all kinds of rashes and eruptions, particularly those of the contagious diseases. Some, of course, are caused by pediculosis vestimentorum. Even though the child be in an ungainly position on the mother's lap, one may note the impaired motility of the chest, either unilateral or bilateral, and ascribe it to lobar pneumonia, bronchopneumonia, pleurisy with effusion, empyema, rheumatism, epilepsy, or tetanus. Whether the patient be asleep or awake, the type of respiration may be observed. It may be slower than normal, stridulous, or of a stertorous rhythm. It is therefore very important that the physician keep in mind the normal respiratory rate of childhood, so that he may readily detect abnormal manifestations. The experienced clinician may sense a respiratory rate for infants of from 40 to 45 per minute, for children under ten years, from 20 to 26 per minute, and, in older children, a higher rate. It is sometimes difficult to detect the respiratory rates where the breathing is shallow and fitful. This respiratory rate in either illness or health must include a consideration of the various factors which influence it; a few of which are exercise, excitement, coughing, inhalation of dust and foul air, etc. Sometimes after a hearty meal, or due to a disordered digestion, there will be an upward pressure of gas from the stomach which may cause an increase in this respiratory rate.

As one proceeds with the examination, the finger tips on the chest wall may note a tactile fremitus, and the examiner may suspect lobar pneumonia, pulmonary tuberculosis, pulmonary infarct, or a compensatory emphysema. On the other hand, he may find a diminished vocal fremitus, and consider pleurisy with effusion, empyema, bronchitis, pulmonary edema, bronchial asthma, or bronchiectasis. Running the finger tips over the lower mammary and intro-axillary regions, one may find a peculiar

friction fremitus whose tactile vibrations have a fine rasping or even a creaking quality. On percussion over the chest, front and back, a dullness or even flatness is encountered, reminding one again of lobar pneumonia, pleurisy, empyema, pulmonary edema, bronchopneumonia, tuberculous adenitis, enlarged thymus, or even pericarditis with effusion. To his surprise, the clinician may find a hyperresonance on percussion, and verify the visual diagnosis of lobar pneumonia, phthisis, bronchial asthma, pleurisy with effusion, empyema, pulmonary edema, or bronchopneumonia. The stethoscope will readily confirm these findings. A characteristic cough usually accompanies the lesions within the body.

When a case of cavernous breathing is met with, one considers chronic pulmonary tuberculosis, bronchiectasis, or lung abscess. A prolonged harsh expiration is often associated with bronchial asthma, phthisis, or chronic bronchitis. If the pediatrician recognizes bronchial voice sounds or an exaggeration of vocal resonance, he is reminded again of lobar pneumonia, phthisis, bronchiectasis, pleurisy with effusion, bronchopneumonia, or tuberculous adenitis.

Listening attentively over the chest wall, both back and front, he may hear sounds of variable pitch, intensity, and quality, dry or moist. He may hesitate on a differential diagnosis of acute bronchitis, chronic bronchitis, lobar pneumonia, bronchopneumonia, influenza, bronchial asthma, pulmonary edema, bronchiectasis, tuberculosis of the lungs, typhoid fever, measles, rickets, pertussis, lung abscess, or infarcts. Confusing, too, are the pleural friction sounds, which may be associated with an acute pleurisy, phthisis, infarcts of the lungs, or lobar pneumonia. With a serous effusion found in the pleural cavity he has but slight diagnostic difficulty, as he considers pleurisy, phthisis, acute rheumatic fever, lobar pneumonia, bronchopneumonia, or grippe.

With eye and finger tip the pediatrician notes possibly a displaced apex beat, and reconsiders pleurisy or pericarditis with effusion, cardiac disease, or, very rarely, a diaphragmatic hernia. Progressively percussing the child's chest on the left side, the physician may find an increased area of cardiac dullness. Then he may expect to find cardiac dilatation, pleurisy, or pericarditis with effusion or empyema. Descending to the abdominal region, he makes a quick visual survey of the surface and then, gently pressing his fingers inward on the abdominal wall, he may elicit pain. From this he will then consider acute general peritonitis, acute entero or ulcerative colitis, bacillary or amebic dysentery, food poisoning, acute intestinal obstruction, acute appendicitis,

tuberculous peritonitis, or possibly Hirschsprung's disease. Pain in the epigastrium may result from hyperacidity, an old fashioned "belly ache," acute appendicitis, or, as is somewhat usual in the case of infants, pylorospasm. An acute gastritis in children often produces tenderness on pressure in the epigastric region. In older children, pain in the right hypochondrium may be the result of an acute cholecystitis or cholelithiasis, but it is very apt to be caused by constipation. When the child complains of pain in the umbilical region, the examination may disclose an acute appendicitis, a tuberculous peritonitis, or a large or small umbilical hernia.

In the iliac and inguinal regions, one usually finds comparatively little manifestation of disease. However, inguinal hernias are not uncommon, and a fecal impaction may be present. If the pains are traced carefully they sometimes uncover a lobar pneumonia, an acute pleurisy, or typhoid fever, and rarely inguinal adenitis. A tenderness in these regions has even disclosed an acute appendicitis. Tenderness over the hypogastrium may denote acute cystitis, acute peritonitis, or a retention of urine.

A general abdominal swelling may or may not be indicative of dangerous symptoms. There may be tympanitis, rickets, achondroplasia, internal obstruction, tuberculous peritonitis, cretinism, Hirschsprung's disease or, as the writer once found, a retroperitoneal sarcoma in an older child. In the area of the epigastrium, a dilatation of the stomach or a tuberculous peritonitis may be found. Drawing his fingers anteriorly over the lumbar region, the examiner will possibly note a swelling over the ascending colon, either in the right flank or well across the abdomen. From this he may strongly suspect intussusception or, in rare cases, an enlargement of the kidney. Tympanitis suggests acute or chronic constipation, acute intestinal obstruction, tuberculous peritonitis, Hirschsprung's disease and, if in the autumn of the year, typhoid fever. If one comes upon a large, usually shapeless body in the left hypochondrium, an enlargement of the spleen, rickets, typhoid fever, splenic anemia, malaria, infantile pseudoleukemia, or acute miliary tuberculosis may be considered. A retracted abdomen suggests characteristic conditions; an acute peritonitis, early signs of tuberculous meningitis, or, as the writer once discovered, a diaphragmatic hernia. Many cases of rigid abdomen result from an acute general peritonitis, acute appendicitis, lobar pneumonia, or from typhoid fever.

With the child lying on his back and the rays of light falling obliquely across the abdominal wall, the physician, standing with his eyes on a level with the body surface, may detect visible

peristalsis. Immediately he considers an infantile pyloric stenosis with resulting dilatation of the stomach, an intestinal obstruction, or, possibly, an idiopathic dilatation of the colon. A swelling in the groin is fairly common and probably the first consideration will be an undescended testicle, the next, an inguinal hernia, particularly if the patient is a boy. Moderately enlarged glands in the groin usually arise from malnutrition, pediculosis inguinale, or scabies.

A general inspection of the body may very possibly disclose kyphosis, lordosis, scoliosis, or a localized tenderness of the spine.

The examiner may discover a case of priapism caused directly or indirectly by a recent circumcision, or a case of adenoids. Furthermore he may discover worms, rectal impaction, bladder distention, or a redness from masturbation.

During his examination the pediatrist often finds anomalies of the external genitals. Many of these are dysfunctions handed down by a damaged germ plasm, among them being congenital stricture of the urethra, epispadias, sometimes hypospadias, phimosis, and cryptorchidism. Many conditions may be seen arising from improper care and from filthy living quarters. In boys, one sees eczema, scabies, intertrigo, and pediculosis pubis on the scrotum and surrounding area. Among little girls are found eczema of the vulva, scabies, and pediculosis pubis, while in older girls the observer may find intertrigo in the genitocrural creases and a prurigo with an associated pruritus.

These diagnostic guide posts await the scrutiny of the experienced man. Pains, aches, coughs, swellings, tone abnormalities, paralyses, atrophies, skin affections, skeletal abnormalities, untoward conditions of behavior, edemas, ulcerations, foot and wrist drop, eversion and inversion of the feet, and many other dysfunctions and pathologic conditions—germ plasmic, congenital, or somatic—are the keys to treatment and prognosis. Education, experience, imagination, enthusiasm, and more, are necessary in establishing many forms of obscure disease and in contrasting them with normal physical conditions. A practical working knowledge of the normal characteristics of the child's body, its weight, size, development, racial and sectional growth impulse, must be understood in order to contrast the pathologic antitheses. The experienced pediatrician will often be able to build up a mental picture of the cause, effect, development, and cure of some baffling disease complex from some obscure symptom or physical feature. Many times a perfect diagnosis is made while the patient is on the examining table. Such diagnosticians are indeed brilliant master-craftsmen.[1]

SENSORY SIGNS OF DISEASE

The senses play an important part in diagnosis, not only those of sight and touch but also those of smell and hearing. Reflex reactions in disease must often be followed out through reason, for they may be indirect in character. The use of the senses in diagnosis is more direct, and they alone may accomplish results where even reason has failed. Many disease conditions can be diagnosed by the sense of smell. The characteristic smell of gastric and intestinal disturbances and the peculiar metallic odor of both nasal and pharyngeal diphtheria are cases in point. The touch of the fingers may disclose painful and sensitive areas of hidden inflammation and of large or small unnatural enlargements in the organs and tissues. The ear discloses uncommon sounds, such as crepitus in fractures, the moving joint depleted of its synovial fluid, the chest sounds in congestion and inflammation of the lungs, and various and peculiar cries of infancy denoting hunger, pain, want of sleep, an uncomfortable position, etc.[2]

REFLEXES

The acceptance by the brain of stimuli emanating both from within and without is followed by a series of biologic occurrences which react on the body and are known as reflexes. Much of the physician's diagnostic ability is the result of his interpretation of these reactions. The biologic cell is intimately concerned with these events. All cells are described as possessing tone, which means a reaction occurring in response to impulses conveyed to the muscles by the nerves but which is not a quality inherent in muscular tissue. The receptive fibrils of nerves are adapted to function by receiving impulses from other nerves, rather than directly from environmental stimuli.

In his examination, the pediatrician may find that the abdomen shows certain areas that are tender to pressure and that this tenderness is limited to certain structures of the external abdominal wall. The areas of tenderness will probably vary greatly in size and shape. A similar pressure, applied at the same time, will cause a sensation, but not pain, to other adjacent areas. This sensation of pain means that some special influence is being exerted from a distance on the tender regions, the effect of which is to increase the intensity of their reaction to stimulation. These areas occur in the distribution of well defined sensory

nerves which are in close association with afferent nerves from th organs within the abdomen. He can observe the exact situation of these areas and thus identify the organ which has generated the impulse.

Abdominal pain is the result of impulses generated in a abdominal organ and conveyed to the central nervous system Here the nerves which supply that particular region in the ab dominal wall are acted upon. In the diseases of childhood, i rarely happens that the area in which the pain is felt is the are in which the disturbance is taking place.[2]

PSYCHIC FACTORS IN DIAGNOSIS

In addition to the physical aspects of diagnosis, there are othe signs which are not so comprehensible, which defy the skill o ear, eye, or hand. These manifestations are psychic in character and must be considered carefully, for we know that the caus of a disease may arise directly or indirectly from the brain. In cases of this nature, a satisfactory diagnosis cannot be made a the bedside nor adequately interpreted at the examining table In the quiet of the study the known facts and observations of a case can be correlated until a mental picture of the cause and effect has been established.

Clinicians have long been aware of the value of a mental diag nosis as an aid in planning the treatment of many obscur diseases. By psychic diagnosis is meant a thorough and genera knowledge of the child's reactions to physical and mental stimuli In many cases this method proves ideal, for the child gives muc valuable information without realizing it. Among the question to which the examiner seeks an answer are, is the child in rea sonably good health or actually ill? If the latter, how seriou is the condition? Does the child's behavior conform to recognize standards? Is he apparently capable of adequate responses t the influences around him? Much experience, study, training and worldly wisdom are required in the correct interpretatio of the responses obtained, and the many and varied feelings tones, moods, and emotions must be often sensed rather tha known.

Every psychic activity, be it a sensation or an idea, is accom panied by a positive or a negative reaction in the child, whic means that he experiences pleasure or displeasure and present moods of "sunniness" or "grumpiness" and emotional states o delight or disgust, joy or grief, love or hatred, anxiety or peace distaste or satisfaction, fear or courage; all of which must be in

erpreted and added to the data of the physical findings in order o obtain a complete diagnostic picture. No two children react he same, nor does any child always react the same, for moods nd emotions fluctuate. Sometimes when quietly thinking over a case recently observed, the character, temperament, and disposition of the child will all be correlated in the examiner's nind: a factor which, in no small way, determines the diagnosis, reatment, and prognosis.

Consider, for instance, the contrast in responses between a hild of sanguine and one of phlegmatic temperament. The lasticity of the mental processes depends unreservedly on the nheritance of certain potentialities. Thought and behavior are argely dependent on moods and emotions, and the observer nust, on the instant, be ready to suppress or add certain points n connection with his diagnosis which he had but a moment before considered from an opposite viewpoint. The examiner inds many remarkable disturbances of behaviorism, some obvious, some suppressed. Another factor of importance in obtaining as complete a diagnostic picture as possible, is the personality of the attendant and the child's reaction to him. Once having gained the patient's confidence, the examination will be much easier and more valuable.

The child who is severely ill loses all interest in his surroundings and concentrates on his own pain and suffering. In the child who is emotionally high strung, sensitive, or mentally afflicted, the gamut of apparent symptoms may run from alpha to omega. In older children, especially in girls, their moods may begin with humility and end in expansiveness. In boys, one uncovers surreptitiously signs of manliness and courage or of humility, or even an evidence of the bully or the coward. Many of these traits of personality are the direct result of a healthy or disordered physical and mental state.[3]

Does it not seem entirely possible that points of apparent triviality, both physical and environmental, definitely affect the value of the diagnosis, even though they may be obscure? Is it wholly through force of habit that physicians find the morning hours the best in which to examine children? Is it not true that in the morning the child shows fewer functional variations of mind and body? During the examination, every effort should be made to keep the child's mental state as cooperative as possible. Any one of a number of irritations, however slight, may make even a superficial examination impossible. These negative influences include the attentions of an overzealous nurse, a slammed door, a strange aroma in the office, be it ether or per-

fume, unfamiliar furnishings, the uniforms, and even a too fixe scrutiny on the part of the examiner. Especially on the fir visit these may cause uncertainty, anxiety, and fear, while th proximity of instruments and the various kinds of treatmen apparatus, and general equipment may bring the emotional sta to a point beyond control. However, in subsequent examina tions, with the child's fear, timidity, and strangeness somewha mollified, the history, environment, personal habits, and genera behavior may be tabulated more completely.

One is inclined to wonder whether or not the married physicia with children of his own has a distinct advantage over h bachelor colleague. Have not his home experiences given him keener psychologic insight and understanding, so that he ma gain more easily the confidence of both parent and child?

The pediatrician's need for education, training, and experienc are beyond question, but these are not sufficient. To them mus be added an imaginative and psychic sense, which in the ve nacular might be called a "hunch," for it is these qualities whic may aid him in deciphering obscure signs when pure scienc fails. These signs, both physical and mental, he reads and in terprets, and from them he senses the degree of functional e ficiency of organs and tissues and formulates the disease-comple It must be understood that while certain organic signs are in dicative of pathologic conditions, there are no reliable an scientific tests available to show whether or not the various tis sues, organs, and systems of the body are working normally an functioning harmoniously to produce the physical condition w designate as health. Any basis of comparison is practically pr cluded, because of the wide range of variation influenced b differences in body build, race, nutrition, and growth impulse

PERSONAL DIAGNOSIS VERSUS LABORATORY

Laboratory methods and technical apparatus have tended t direct attention from personal diagnosis to those tests establishe at the scientific workshops. However, the laboratory is a mean rather than an end, and aids the physician in completing h diagnosis.

Reagents in tubes and crucibles, although beautiful in colo and exact in pure chemical reactions, cannot be compared to th thousands of biologic reagents occurring in the child's organism which are not visible. In many cases, the diagnosis is purel materialistic rather than psycho-materialistic, and tends to con form to standards set by text books and instilled by instructor

Too often conditions are dealt with as they appear at hand, without taking into consideration the circumstances which influence these conditions.

In many instances some fanciful remedy is given the credit for a recovery, when nutrition alone has brought it about. Many diseases have an etiology so obscure that the most detailed study from every possible aspect is highly essential. The greatest diagnosticians are those who gladly accept aid from others whose experience has been wide in the particular field involved. With the disease correctly recognized, the treatment may be confidently undertaken.[5]

DIAGNOSTIC DIVERGENCES

Considering the many mental characteristics and body variations inherited or somatically induced, it is often difficult to draw the line between what is known as normal, or "health," and what is known as abnormal, or "disease."

The variations in children are limitless, and many who seem completely normal fall far short of the standards set for them by scientists. Sometimes the child will be one or two years ahead of or behind the established rate. Were it not pathetic, it would be most amusing to hear a perturbed mother bemoan the fact that her child is a few pounds heavier or lighter than some one has told her he should be. The child weighing a few pounds more or less than what is usually considered as the standard may be in perfect health as judged by every test and observation, while the child whose weight agrees exactly with the standard may be obviously ill.

The growth impulse and the rate of growth are, to a large extent, dependent on proper nutrition, and the basis of weight for height has proved, in our experience, a fairly accurate measure of the degree of malnutrition and illness. It is a well known principle that a body of a certain height requires a certain weight to sustain it. Therefore, one of the important points in history taking is to find out if the child has lost weight or if height and weight have remained stationary. Needless to say, healthy children do not remain stationary in weight and height for a very long period.

In the height-weight relation, allowance should be made for the type of build of different children of the same race, as well as for those of the various alien races. The tall, rangy child is constantly being urged by his parents to eat more, for the family physician has shown them that the child does not correspond

TABLE 1

WEIGHT—HEIGHT—AGE TABLE FOR BOYS OF SCHOOL AGE

Height (inches)	Average Weight for Height Lbs.	5 Years	6 Years	7 Years	8 Years	9 Years	10 Years	11 Years	12 Years	13 Years	14 Years	15 Years	16 Years	17 Years	18 Years	19 Years	Height Inches
38	34	34	34														38
39	35	35	35														39
40	36	36	36														40
41	38	38	38	38													41
42	39	39	39	39	39												42
43	41	41	41	41	41												43
44	44	44	44	44	44												44
45	46	46	46	46	46	46											45
46	48	47	48	48	48	48											46
47	50	49	50	50	50	50	50										47
48	53		52	53	53	53	53										48
49	55		55	55	55	55	55	55									49
50	58		57	58	58	58	58	58	58								50
51	61			61	61	61	61	61	61								51
52	64			63	64	64	64	64	64	64							52
53	68			66	67	67	67	67	68	68							53
54	71				70	70	70	70	71	71	72						54
55	74				72	72	73	73	74	74	74						55
56	78				75	76	77	77	77	78	78	80					56
57	82					79	80	81	81	82	83	83					57
58	85					83	84	84	85	85	86	87					58
59	89						87	88	89	89	90	90	90				59
60	94						91	92	92	93	94	95	96				60
61	99							95	96	97	99	100	103	106			61
62	104							100	101	102	103	104	107	111	116		62
63	111							105	106	107	108	110	113	118	123	127	63
64	117								109	111	113	115	117	121	126	130	64
65	123								114	117	118	120	122	127	131	134	65
66	129									119	122	125	128	132	136	139	66
67	133									124	128	130	134	136	139	142	67
68	139										134	134	137	141	143	147	68
69	144										137	139	143	146	149	152	69
70	147										143	144	145	148	151	155	70
71	152										148	150	151	152	154	159	71
72	157											153	155	156	158	163	72
73	163											157	160	162	164	167	73
74	169											160	164	168	170	171	74

TABLE 1—Continued

Age—Years		6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Average height (inches)	Short	43	45	47	49	51	53	54	56	58	60	62	64	65	65	
	Medium	46	48	50	52	54	56	58	60	63	65	67	68	69	69	
	Tall	49	51	53	55	57	59	61	64	67	70	72	72	73	73	
Average annual gain (pounds)	Short	3	4	5	5	5	4	8	9	11	14	13	7	3		
	Medium	4	5	6	6	6	7	9	11	15	11	8	4	3		
	Tall	5	7	7	7	7	8	12	16	11	9	7	3	4		

Baldwin and Wood

o the height and weight standard for his age. On the other hand, the parents of the short, stocky, "thick-set" type of offspring are constantly complaining of the child's appetite and excess weight. In the same racial stock some children may be shorter than others of the same age or heavier than others of the same height. In England native children of Anglo-Saxon stock, both white and colored, are taller than children of corresponding ages of Latin parentage. When it comes to the question of weight for age, the heaviest children are the Negroes, the Russians, and the Latins. The height-weight ratio is shown to be greatest for Latins and least for Anglo-Saxons.[4] When, indeed, the parents asks what immediate factors constitute a general visual impression of the physical well-being of a child, the physician replies that it is probably the relationship of height, weight, and age. However the general growth and development of the teeth and nails are also visible signs of health or disease. Many scientific formulae and tests do not answer the questions as capably as does nature herself.

While it is manifestly unfair to expect the physician to have at his finger tips the standard weight for height and age of the patient, the clearer general mental picture he has of these proportions, the easier he will find the diagnosis. Baldwin and Wood have prepared data along these lines which are painstakingly complete. The figures come from records on 74,000 boys and 55,000 girls, presumably healthy. In these gross figures there have been included 24,000 measurements for boys and 12,012 measurements for girls, upon whom five to fourteen consecutive measurements have been taken, nearly all at yearly intervals. The measurements were taken by trained examiners, with standard methods, and on nude children.[4]

TABLE 2

WEIGHT—HEIGHT—AGE TABLE FOR GIRLS OF SCHOOL AGE

Height (inches)	Average Weight for Height Lbs.	5 Years	6 Years	7 Years	8 Years	9 Years	10 Years	11 Years	12 Years	13 Years	14 Years	15 Years	16 Years	17 Years	18 Years	Height (inches)
38	33	33	33													38
39	34	34	34													39
40	36	36	36	36												40
41	37	37	37	37												41
42	39	39	39	39												42
43	41	41	41	41	41											43
44	42	42	42	42	42											44
45	45	45	45	45	45	45										45
46	47	47	47	47	48	48										46
47	50	49	50	50	50	50	50									47
48	52		52	52	52	52	53	53								48
49	55		54	54	55	55	56	56								49
50	58		56	56	57	58	59	61	62							50
51	61			59	60	61	61	63	65							51
52	64			63	64	64	64	65	67							52
53	68			66	67	67	68	68	69	71						53
54	71				69	70	70	71	71	73						54
55	75				72	74	74	74	75	77	78					55
56	79					76	78	78	79	81	83					56
57	84					80	82	82	82	84	88	92				57
58	89						84	86	86	88	93	96	101			58
59	95						87	90	90	92	96	100	103	104		59
60	101						91	95	95	97	101	105	108	109	111	60
61	108							99	100	101	105	108	112	113	116	61
62	114							104	105	106	109	113	115	117	118	62
63	118								110	110	112	116	117	119	120	63
64	121								114	115	117	119	120	122	123	64
65	125								118	120	121	122	123	125	126	65
66	129									124	124	125	128	129	130	66
67	133									128	130	131	133	133	135	67
68	138									131	133	135	136	138	138	68
69	142										135	137	138	140	142	69
70	144										136	138	140	142	144	70
71	145										138	140	142	144	145	71

TABLE 2—Continued

Age—Year		6	7	8	9	10	11	12	13	14	15	16	17	18	
Average height (inches)	Short	43	45	47	49	50	52	54	57	59	60	61	61	61	
	Medium	45	47	50	52	54	56	58	60	62	63	64	64	64	
	Tall	47	50	53	55	57	59	62	64	66	66	67	67	67	
Average annual gain (pounds)	Short	4	4	4	5	6	6	10	13	10	7	2	1		
	Medium	5	5	6	7	8	10	13	10	6	4	3	1		
	Tall	6	8	8	9	11	13	9	8	4	4	1	1		

Baldwin and Wood

Data for these figures were collected from a wide territorial range, including New York, Boston, Illinois, Missouri, and Iowa. The authors considered that the annual increment of growth is of greater importance than the weight or height at any given age. These figures tend to show that the question of diagnosis, treatment, and prognosis rests on no standardized rules. In order to show the difference in the growth of tall, medium, and short children and to give yearly increments in weight, the middle 75 percent of all the children within each age group for height are classified as of medium height; the 12.5 percent above this group, as tall children; the 12.5 percent below as short children.

These increments show that tall children have the acceleration in growth, both in height and weight, at adolescence earlier than medium children, and that medium children have their acceleration earlier than short children.

For each year in the earlier ages (five to ten years) both boys and girls show a variation of two to three pounds in weight at each inch in height (read the weight column vertically). On the other hand, the weight for a given height varies little from year to year for the same period; however, after the eleventh year this increase is marked (read weights horizontally). These facts regarding the normal growth of adolescent children make it impossible to express proper weight for height without taking into consideration the age factor.

In the tables the average annual increment gives a general basis for comparison of the growth of tall, medium, and short children.

The limitations of all growth tables should be recognized. They do not aim to present a complete clinical picture of a child's physical condition. However, the relation of weight to height and age is the best single index of general health and

TABLE 3

WEIGHT—HEIGHT—AGE TABLE FOR BOYS FROM BIRTH TO SCHOOL AGE

Height (inches)	Average Weight for Height (lbs.)	Months of Age											
		1	3	6	9	12	18	24	30	36	48	60	72
20	8	8											
21	9½	9	10										
22	10½	10	11										
23	12	11	12	13									
24	13½	12	13	14									
25	15	13	14	15	16								
26	16½		15	17	17	18							
27	18		16	18	18	19							
28	19½			19	19	20	20						
29	20½			20	21	21	21						
30	22			22	22	22	22						
31	23			.	23	23	23	24					
32	24½				24	24	24	25	25				
33	26					26	26	26	26	26			
34	27						27	27	27	27			
35	29½						29	29	29	29	29		
36	31							30	31	31	31		
37	32							32	32	32	32	32	
38	33½								33	33	33	34	
39	35								35	35	35	35	
40	36½									36	36	36	36
41	38										38	38	38
42	39½										39	39	39
43	41½										41	41	41
44	43½											43	43
45	45½											45	45
46	48												48
47	50												50
48	52½												52
49	55												55

Woodbury

TABLE 4

WEIGHT—HEIGHT—AGE TABLE FOR GIRLS FROM BIRTH TO SCHOOL AGE

Height (inches)	Average Weight for Height (lbs.)	Months of Age											
		1	3	6	9	12	18	24	30	36	48	60	72
20	8	8											
21	9	9	10										
22	10½	10	11										
23	12	11	12	13									
24	13½	12	13	14	14								
25	15	13	14	15	15								
26	16½		15	16	17	17							
27	17½		16	17	18	18							
28	19			19	19	19	19						
29	20			19	20	20	20						
30	21½			21	21	21	21	21					
31	22½				22	22	23	23	23				
32	24					23	24	24	24	25			
33	25						25	25	25	26			
34	26½						26	26	26	27			
35	29						29	29	29	29	29		
36	30							30	30	30	30	31	
37	31½							31	31	31	31	32	
38	32½								33	33	33	33	
39	34								34	34	34	34	34
40	35½									35	36	36	36
41	37½										37	37	37
42	39										39	39	39
43	41										40	41	41
44	42½											42	42
45	45												45
46	47½												47
47	50												50
48	52½												52

Woodbury

nutrition, as well as the best criterion of normal growth that w possess. According to the authors, a weight deficiency cha should be included in the list of important indications or sig for which the child should be given more careful profession attention.

The range of variation within what may be considered norm limits is greater beyond the ages of twelve or thirteen years tha at earlier periods. It is impossible to fix definitely what th range is. The tables given are not to be regarded as a fin statement of weights of children of different races and of differen economic status. Only mean weight values should be considere as occurring between more elastic limitations.[6] Woodbury ha worked out substantially the same tables, but has used low ages.

During the spring and summer of 1918, the Children's Burea inaugurated a weighing and measuring campaign. Record card for over two million children from all parts of the country wer received. The records tabulated were those for children withou serious physical defects. The children were of both native an foreign stock.[7]

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CHAPTER 7

MEDICINE

PRIMITIVE RELIGION AND DISEASE PREVENTION

Among primitive peoples, the prevention and treatment of disease was, and often still is, relegated to some power in the universe greater than that of man. When man is faced with the unknown and the inscrutable, or with some overwhelming unfulfilled desire, he bethinks himself of his gods, of his religion, and of his ultimate seat in paradise. His spiritual belief often helps to sustain him in health—"believe, and it shall be given unto you." In the treatment and prevention of disease, magic and religious forms of one kind or another belong to human experience and are bound up mysteriously with body betterment. These religious beliefs are instilled in the children, and who can say that they are not the better for them? The brain and body are a harmonious unity. However, this unity cannot arise from a religious belief alone, but must be supplemented by environmental factors, even though Christian Science tells us otherwise.

Some of the efficacy of modern medicine lies in impressiveness and belief in physician, healer, magician, or priest. This belief, when associated with remedies, enables them better to fulfill their aims. The student of medical history recalls the early strivings for the healing of disease as revealed in the records of the earliest Egyptian papyrus and in Babylonian, Hindoo, and Mosaic inscriptions, which throw light upon religious incantations, and indicate that an appeal was made by the ill and discouraged to the temples of the gods for divine healing:—"Rise and your sins will be forgiven." The ancients employed oracles, sleep, dreams or visions, spells, omens, incantations, the touch or tongue lick of sacred animals, and the priestly application of herbs, waters or massage. They possessed an imagination much like that of followers of the modern pseudo-religious cults, which overruled failure.[1]

Disease was looked upon as a definite entity, something placed in the body through the agency of malign influences resulting from demons or from the spirits of human enemies or from animals killed in the chase. To cure a disease was to induce it to leave the body; its departure being hastened by cutting holes in

the skull, punching the victim, administering nauseous me cines, or by means of charms, amulets, incantations, or sometin by the slaying of a human or animal, as is now practiced in t mountains of Honduras and known as voodooism; by astrolo and by omens in the viscera of slaughtered animals.[2]

Even today some men believe that through mysticism, anc tral spirits, exorcism or transference, burnt offerings, camp me ing revivals, revivalist exhortations, or through faith of so sort, disease can be both cured and prevented without oth means. Journeying through many lands, one's attention is oft arrested in out-of-the-way corners, by the superstitious custon as seen in rituals and in the use of herbs, potions, and foods.[1]

The ancient Mayas gave evidence of the divine character corn meal in their festivals and religious observances. The Ma and Aztec peoples and those of South America in general plac the power of healing and of disease prevention in the hands their gods. However, these various usages represent a theurgi theosophical, or hyper-physical system which lies wholly outsi and beyond the conception of the natural law of cause ar effect with which we are concerned. Within the shadows of mo ern temples of learning and wisdom there flourish, even toda in other less learned institutions, the weeds of ignorance, pseud science, superstition, and mystery.[1]

THE GODS OF HEALING

In Egypt, Ra, the sun god, was believed to be the founder state religion and also the deity associated directly with healin Osiris was the god of the Nile and of immortality. His sister, Isi was the goddess of vegetation and fertility, as well as a popul divinity of health and domesticity, caring in particular for th health of women and children. Horus was the offspring of Osir and Isis, and she taught him magic and its application to healin and prevention of disease. Ptah was the god of wisdom; indee the creator of gods and of men famous for their power of healin Thoth, the moon god, was the creator of knowledge and scienc including medicine.

The Greeks, too, had their temples of healing, and probabl went further in preventive measures than did the Romans an Egyptians. Their institutions were dedicated to Asklepios, th god of medicine. Their temples were distributed throughou Greece, notably at Cos, Cnidus, Epidauros, Mitylene, Athen and Pergamos. They were not used for ordinary worship, bu presented rather the aspect of open-air sanitaria, much like thos

e have at present, and were in the hands of the priests of sklepios, the god of health, who used a few remedies pronoting elimination and caused temple sleep facilitating psychoherapy. These priests gave advice and practiced dietetics, cleaniness in healthy living, recreation, and methods to ward off disase. Healing gods possibly survive today in the spirits of Mary Baker Eddy, Ivan Suslov the Khlystyst, Coué, John Alexander Dowie, and others.

A reminder of past sorcery is seen at the present time in the pow-wow performances of the Indian medicine man for the prevention of disease. He employs mysticism through the use of angible things—blood, hair, saliva, teeth, leaves, skins of birds and reptiles, or intangible objects such as rays of light, shadows, echoes, noises by means of incantations, words, names, and by "spells." His dress is often imposing and awe-inspiring and consists of tokens, emblems, teeth, bones, beads, and trappings. Relics of mysticism survive today among the intelligent, in the form of finger rings, amulets, eardrops, and necklaces, which are often used to ward off ill luck, to gain happiness, and to prevent disease.

It may well be said that the attainments of ancient peoples, particularly the Egyptians, in hygiene and prophylaxis ranked higher than did their therapeutics. The Egyptian form of disease prevention was established as a recognition that many current ailments were derived from overeating, from insufficient and improper food, or from the failure to keep the alimentary canal open. There seems to be nothing new under the sun. These people considered that every disease was caused by a faulty dietary, and while means must be taken to cure or prevent it, these means should be simple and harmless. They might have used our own words, for surely we can use theirs; and when we talk of balancing metabolism they might have expressed similar thoughts centuries ago.

Consider the simplicity of their diet and its excellent balance. A varied diet, consisting of bread, barley, millet, wine or beer, fish, meat, fruit, was theirs. The Egyptians advocated cleanliness in food preparation; meat inspection and even the inspection of the animal itself, of its viscera and blood, was controlled by the priests both before and after slaughter. The water used by these prelates was boiled and filtered. Regular habits of purgation formed a part of hygienic custom, in that for three consecutive days in each month emetics and enemata for prophylactic reasons were considered essential. Preventive measures against disease were enacted by the priests by curbing an excess of wine

and beer drinking. They checked extreme sexual indulgenc and bent their efforts to control sexual perversion, self-abus contraceptive practices, and abortion.[11] The cleanliness of th body and clothing was insisted upon, attention was even give by those progressive ancients to sanitation, though perhaps in crude way. Refuse was removed from houses in much the sam way as at present. Dwellings were fumigated and perfumed especially in times of disease and epidemics. Bites of insects an vermin in general were either avoided as much as possible o were attended to when unpreventable. The advantages of salubrious climates were stressed.

DEMONOLOGY

Superstitions sway people today much as they did our forebears, and tend to obstruct the work of the pediatrician in disease prevention as well as in his efforts to obtain cures. We ar reminded that the elder Pliny recorded many crude forms o sorcery. One is also inspired to study Babylonian and Assyrian beliefs in aggressive and defensive demons in the treatment of disease. With a credence in demonology and demoniac fetishes associated with witchcraft, people wandered hopelessly through the mysteries of meteorology, astrology, obsessed with the supposed therapeutic effects of the sun, moon, and stars, the mystery of days and dates concurrent with various forms of disease treatment and prevention.[1]

THE MOSAIC LAW

The Mosaic Law of the Pentateuch was edited, amplified, and redressed before being absorbed into the Talmud of the Jews. This Pentateuch, according to modern authorities, dealt not with the specific words or speeches of Moses, but with a miscellaneous collection of ordinances written by different hands at different times. It was derived from varying sources over a period of not less than eight hundred years after the death of Moses, and was to be added to and embellished in the Talmud seven hundred years later. The Pentateuch became the book of law; and bound up with its teachings is the Torah of the Hebrews, who were the founders of modern public hygiene. Moses provided a national code of laws for the health of the body and the mind of the civilian community; laws derived partly from Egyptian and Babylonian sources. The eight great principles of this sanitary law stand out today as clearly defined measures for

alth. Had Judaism given nothing more to mankind than the tablishment of a weekly day of rest for the restoration of body gor alone, we should have to consider it as one of the greatest nefactors of mankind.

Nevertheless, it must be admitted that preventive medicine id the search for immunity to disease remained for centuries a state of arrested development, for there was little or no ppreciation of natural law and of the principles of physiology of methods to liberate science from the fetters of superstition id of ignorance.

GRECIAN INTELLIGENCE

The Greek intelligence was a thinking, doing, and idealistic ie, and we question whether any one sentence can better symolize the greatness and progressiveness of these people in the matr of health, disease prevention, and treatment than that famous ne of Sir H. Maine, "nothing moves in the modern world that not Greek." The Greeks introduced into the mind of the ncient world two new conceptions; rationalism and naturalism, ill unlearned by many today. They had ideals as to freedom thought, love of physical beauty, and humanism; and, they ooked upon life with directness and sanity.

The Greek spirit in medicine comprised at least four moveients, mixed with alien prejudgments and with local and foreign aditions. There was first the movement which might be termed ie Ionian philosophy. A little later came the birth of Hippoatic medicine. Lastly there was the dissemination of Greek iedicine which followed in the wake of the conquests of Alexnder the Great, which was embodied in the Alexandrian School. t was the combination of these four separate movements which onstituted Greek medicine, different from anything that had one before, and which, in time, became the link between the ind of medicine heretofore practiced and that of the present day.

The student can sense the Greek vision of immunity as deived from a better heritage and from improved environment.)ne is not forced to imagine the progressive reasoning of Grecian iought as to physical and mental hygiene in the science and rt of preventing disease and of maintaining health, for he knows om history that such were facts and not hearsay. The ancient reeks, too, were conscious of social evolution in the makeup of ien, and they focussed their attention on the mind fully as much they did on the body. They were inquisitive, and when it ame to a question of methods for disease prevention they evinced

great interest in the progressive development of the hum mind, and the effect which social circumstance, education, a environment had upon it. They admired also the possession of responsive and investigative temperament. Indeed, they mu have pondered over these things during those dreary days of t ebb and flow of scientific advancement and retrogression, tho dark days when happiness gave way to despair. Even in tho black, black days they envisioned a plastic and liberally endow mind, which would provide means to understand the body as whole.

It is true that these new thoughts were slow in finding a ferti soil in which to take root, but the Greeks had a noble inspir tion and kept steadily on. Carefully they tended these seeds social and physical betterment, of the education of man, a considered his distribution in the world and his reactions to it Thinking back over those things which we consider essential the establishment of health and immunity in our children, w find that many of our present ideas were recognized by tho early Greeks. A conspicuous example is the benefit to be d rived from physical exercise.

FIGURES IN MEDICAL HISTORY

That mighty figure, Claudius Galen of Pergamum, lived 60 years after Hippocrates, and became the greatest master of scie tific methods from the second century to Roger Bacon. One ca not forget, however, the prowess of Deomcedes of Croton, n of that great Roman soldier and water commissioner, founder the beautiful Roman baths, Sextus Julius Frontinus. After th decline of the western Roman Empire, the tradition of med cine passed, but with some degree of decadence, to the Byzantin Empire. One may trace a path to Gondisapor, the birthplace Arabian medicine, to Bagdad, through Persia, Arabia, Syria, an Sicily, and through Spain, where medical schools and hospita were founded.

Both light and shadow fell on preventive medicine from th fifth to the fifteenth centuries, at which time these shadows per ceptibly deepened until the dawning of the Renaissance, a perio which heralded the rejuvenation of medicine. England an Europe alike were now feeling their way through the blackne toward the organization of human society. It was the period the Middle Ages, a period of manors, monasteries, and guilds, period of learning for the rich, who held themselves disdainfull aloof from the common people. Yet the latter learned from them

in a small way, how to control disease through cleanliness and hygiene. They even founded organized relief for their poor members.

The monks of those times were the real leaders in the community, establishing libraries, schools, hospitals, dormitories, cloisters, and guest houses. They taught the serfs a knowledge of house sanitation and land drainage. They also practiced blood letting for fevers, cultivated physic gardens, and served their poor retainers as apothecaries.

Possibly the famines and pestilences of these ancient times, with their aftermaths of physical and mental weakness and despondency, prepared the soil for the host of diseases which were abroad in the land; phthisis, scrofula, jaundice, dropsies, fluxes, boils, and maladies peculiar to women. Child mortality was high, and leprosy and the bubonic plague, which was known as the stones, St. Vitus' dance, palsies, and many other ills; all of which instinctively turned the minds of the survivors to the need of a better regimen for disease control. The frightful loss of their families and fellows turned their thoughts to social and medical organization as applied especially to quarantine and general sanitation. For the time being, a peculiar psychologic influence was exerted by the Black Death. During this period, fatalism flowered, morals were relaxed, suddenly acquired wealth was squandered in riotous living, the fear of God and all religious observances declined and withered.

Before the Renaissance, the knowledge of medicine was purely empirical, with the exception of that period dating from Galen to Roger Bacon.[1] This means that the Renaissance ushered in the basic study of the nature of man, of life, of physiology of nutrition and immunity, and of their interrelationship.

ANATOMY AND PHYSIOLOGY

Another innovation at this time was a dawning realization of the beauty to be found in nature and especially in the human form. At first thought it may appear strange that painters, not doctors, first opened the eyes of men to the beauty of the physical balance of the human body and to the opportunities for study along these lines. Giotto, Leonardo da Vinci of Italy, and Albrecht Dürer of Germany were perhaps the outstanding painters who demonstrated the beauty of the human form. Among the countries which were influential in directing attention to anatomy, both as a study and an expression of art, England and Germany were prominent.

While that eminent Belgian, Andreas Vesalius (1514), is gen erally thought of as the founder of modern anatomy, it is quit probable that the surgical and anatomical studies and teaching of Ambroise Parie and Paracelsus were also valuable contribu tions to the subject. William Harvey next appeared on the scen and physiology was still further advanced by his theory of th circulation of the blood. This new explanation opened up an made possible more advanced conceptions of the function of th blood itself; its nutritive value, its chemical content, and it relation to health and disease.

PATHFINDERS IN PREVENTIVE MEDICINE

Before turning more fully to modern ideas, one must not forge the epoch-making career of Claude Bernard, for it was he mos of all who in pre-modern days built the framework of our presen conception of preventive medicine.

In closely scrutinizing the research work on physiology o those medical pathfinders in the sixteenth and seventeenth cen turies, we cannot fail to observe that their observations on pre ventive medicine, although primitive and elemental, ran some what parallel to those of the present day.

In these pages, unfortunately, we can merely mention th clinical work of the anatomists, naturalists, physicists, an herbalists in the sixteenth century. Nor can we include the wor of those illustrious men, Banckes, Turner, Gerard, Glisson Mayerne, and Sydenham, in the seventeenth century, and thos clinical practitioners of the eighteenth century, Mead, Floyer Sloane, Fothergill, Lettsome, Cheselden, Huxham, Herberden Haygarth, or Hewson. The obstetricians, the Hunters, Pringle Pott, Wothering, Blane, Baker, Baillie, and Jenner, every on of whom added his name to the advancement of preventive medi cine and to our newer conception of immunity, must not b overlooked. Even during the period of 1743 to 1752, Cadogan Trotter, and others showed that the enormous consumption o alcohol common at that time induced gout and other disorder of metabolism and impaired the constitution.

There sprang up, in the last half of the eighteenth century an industrial revolution which led Percival and Ferrier of Man chester to interest themselves in the problems of the enslave working classes, in their unwholesome surroundings, poor food faulty hygiene, and in the relationship of disease to unsanitar crowding.

Space limits our desire to extol the genius of many publi

spirited men, for instance, Peter Chamberlen, 1625-1628, barber and surgeon; William Hunter and William Smellie, in their clinical work in midwifery and in the prevention of puerperal sepsis.

In the matter of modern antiseptic practices and methods in lying-in hospitals and the supervision of mothers and infants, Smellie's work could well be called practical according to present day standards. Even more modern are the conceptions of occupational disease prevention. We may point out, too, the great decrease in mortality from scurvy, anthrax, smallpox, typhus, typhoid, diphtheria. Down the centuries there has been an unconscious trend toward humanism and to the education of the people so that they may be better fitted to accept the fruits of the scientific labors of so many great men. In spite of wars and rumors of wars, in spite of depression, poverty, and misery, we see mankind advancing. Far back in their subconscious minds, however, people harbor the delusion that antiseptics, antitoxins, antiscorbutics, vaccines, sera, and insulin confer by their use perfect immunity. With this we disagree, for perfect immunity can come about only with the cooperation, the coordination of the well-functioning biologic cell; and this cell is disturbed, it stands to reason, by drug medication.[1]

MODERN PREVENTION OF DISEASE

The modern science of medicine is concerned with the prevention of disease rather than with its cure, but the methods used in both cases are remarkably similar. This is as it should be, if we are interested in the production of virile and progressive human beings. We might perhaps define the subject of preventive medicine as that branch of the science and art of medicine which is concerned with the preventive aspects of the healing art as distinct from the curative. In practice the two cannot be separated, yet each represents in varying degree a different specific purpose. The avoidance of disease and the prevention or reduction of its sequelae are obviously not identical with its remedy and cure.

The young pediatrician of today enters upon his career with three definite concepts. He may consider the accepted idea of medicine as a remedy or cure for disease, or he may consider that his mission lies in its prevention through diagnosis, and in reducing or modifying its results or disease-producing factors. He may be interested in life itself, as it concerns nutritional, social, physiologic, psychic, and other environmental factors,

and their influence on the natural defenses of the child in relation to disease prevention. He favors constructive medicine and therefore a balancing of metabolism.

Modern scientific thought on disease prevention has, in the past decade, pressed forward with determination. It runs something like this:—(1) Foundation and development of the cellular theory; (2) Dynamics of the circulation and constant content of the blood; (3) Biochemistry of nutrition, digestion, and assimilation; (4) Nervous regulation and integration; (5) Muscular and nervous control; (6) Endocrinology; (7) Physiology of respiration.

The germ and the soma are intimately associated all through life, and the rational consideration of the child's health is the acknowledgment of this association. There are very few somatic diseases that do not have their inception in heredity and no true hereditary dysfunction that does not owe its development to the soma. In the study of disease in children, whether of hereditary or somatic origin, too little work has been done upon its causative and fundamental factors, and too much upon its pure symptomatology. It is easy to give a drug for pain, but much harder to investigate the source of that pain and prescribe a rational diet and suitable environmental associates. The seriousness of the symptoms, complications, sequelae, and termination of any disability will be directly proportionate to the importance of the normal functions of the affected cells. Rational therapeutics, whether concerned with the mother or child, considers the cell and its activities and selects the type of treatment that will remove disabling causes and restore the channels of pure blood supply to the disabled cells, and the channels of drainage from them. Furthermore, it will assist the cells to throw off their loads, to eject their poisons, to absorb kinetic energy, and to add to themselves reparative and building material, thus restoring their normal relationship to the rest of the body.

Nature has basically but one definite remedy—the blood. If nature were always successful in her efforts, no therapeutic assistance would be required. The body would be its own physician. Pathological conditions all resolve themselves in cellular disability, altered blood supply, and impaired drainage. To supply the disabled as well as the healthy cells with blood, the following combination of agencies must work in harmony: cardiac integrity and rhythm; vascular continuity and permeability; lymphatic continuity and permeability; normal blood constituents, which in turn depend upon adequate qualitative and

quantitative diet; alimentary adequacy to convert diet into soluble kinetic energy and to adjust reparative and building materials: pulmonary respiratory exchange and capacity; renal, dermal, and pulmonary excretion; endocrine balance between pituitary, thyroid, adrenals, gonads; periodic removal of waste due to diet; automatic cerebrospinal-sympathetic control and coordination, including special sense organ functions. The unbalance of these normally harmonious forces disables the cells, with resulting dysfunction of the organs, which in turn control other organs.

TYPES OF DISEASE AND THEIR PREVENTION

Two main classes of diseases are recognized:—first, those which are not transferable, known as noninfectious; and, second, those which are transferable, or infectious diseases. The causes of the first type are poisons injected, inhaled, or absorbed; and traumatisms, mechanical, thermal, and electrical. The second class points to live animals, humans, and parasitic plants as the transmitting causes.[3]

It is only in the exogenous diseases that one can hope for cure through proper diet assisted by environmental associates, through medication, and perhaps through operative measures. To treat inherited morbid conditions of severe character, such as major dysfunctions, is very difficult, since often one is able to employ only symptomatic measures. Even here, however, much can be done toward balancing the organism through proper metabolism, but no one can wholly correct the hereditary pathological defect per se, and it must be constantly combatted. To illustrate, one cannot so completely cure myopia or hyperopia that glasses need not be used, nor can one prevent the diatheses of club foot, diabetes, or mental derangements from being transmitted, once they are on their way. But these taints can be blotted out from later generations through selection in mating.[4] Adequate treatment of hereditarily damaged organs in severe cases is often not permitted us, but the prevention of such diatheses in succeeding generations can often be accomplished.

Physicians may commonly recognize a tendency to certain traits and dysfunctions before the diseased condition manifests itself and can neutralize its dangerous influence. For instance, it is known that the endocrines are concerned with the regulation of body growth and physical development. Nutritional, physical, psychic, and other environmental agencies, acting through the central nervous system on the endocrines, tend to

modify the size, structure, and function of the body organs of the child. The effects of a damaged endocrine system in the parents can obviously influence the rudiments of these organs in the child. It is therefore the responsibility of the physician to study the physical and mental characteristics of the parents, and if possible of the grandparents, so that he may more readily understand the trend of development of dysfunction and disease in the child.[5]

It is with the minor traits, dysfunctions, and diatheses that the pediatrician has mostly to deal. Without his aid, many of these variations, with their potentialities for evil, might become gross in character and overwhelm the child. A positive cure of extreme disease mutations can never be wholly assured even by the most expert, for one can never be positive that while he is treating one of them there may not be others lurking in the background. The complete eradication of these undesirable transmissions is possible only through the improvement of the germ plasm by the cross breeding of better strains, when the dominant features of these strains tend to become paramount in inheritance.

However, even with the most perfect selection, and when the dominant traits can be more or less regulated for good, there is always the chance that pathological recessive factors may crop out at any time. Novels are founded on such instances, and there is hardly a family, however aristocratic, however gifted, which cannot point to some more or less distant relative with disapproval, even with disgust. Could one control mating by such selective measures as animal breeders use, or by the wise methods of selection employed by the families of many European households, one might look for a perfect race. But as long as sex emotionalism is allowed to flourish without wise restraint, and as long as alien races of irresponsible ancestry are allowed to intermarry, the pediatrician must stand by and do the best he can.

THE EUGENIC PROGRAM

By far the best move toward organizing an improved society through the eradication of transmitted diseased characters has been made by the eugenists. Unfortunately, many purists among them travel a bit further in their beliefs than clinical experience would seem to warrant. They insist that the anatomic, physiologic, and psychologic potentialities are determined by the germ cells. All the main characteristics of our personalities

were born with us, they contend, and they cannot be changed except within relatively narrow limits. That environmental factors modify such traits is, according to their viewpoint, improbable, if not impossible.[6] Clinical observation does not support these conclusions. Indeed the eugenic program plans the elimination of all transmitted physical and mental defects by the cross breeding of sounder and improved strains. Such a program is progressive, altruistic, and in all ways excellent, but with human nature constructed as it is, with unwise selection arising from the flow of uncontrolled emotionalism, eugenic Utopia may never be reached. Even could such a condition be brought about, could it even partly succeed, recessives, often atavistic in character, might casually crop up.

Huxley is more sanguine of the future of eugenics when he says that the next step in the goal of scientific eugenics toward the production of a better race of men will be the application to human propagation of the very same artificial methods now employed in breeding thoroughbred horses and cattle.

When this comes about, probably within a generation or two, the character of marriage as an institution will be radically changed. Men and women will marry for love and companionship, while the propagation of the race will be accomplished wholly outside the institution of marriage. That means that a wife's children will not necessarily be those of her husband, while her husband's children will be not only his wife's, but also those of many another man's wife, provided both mates are of superior stock.[7]

While it is generally believed that all men are born equal, it is a fact not to be disputed that they do not remain so. When the phrase, "All men are equal," is rightly interpreted, it means to convey the idea that humans spring from a psychologic laboratory or from a school of physical culture. Yes, in all the common rights of man, in the right to live, in the right of liberty, and in the pursuit of happiness, humans are indeed equal. Unhappily, the eugenists' admonition to mate with only the best of strains may make but a weak impression; for even with tact, optimism, altruism, and diplomacy, no one can control heredity, for he cannot control humans. Pathologic variations may spring from the stock of the least suspected families, those who boast with pride of their clean ancestry. Eugenically, it cannot be denied that individuals selected as possessing certain mental and physical characteristics, and with these particular qualities developed by environment, who are mated with individuals matured along the same lines, might conceivably evolve a superior race of be-

ings, say, in two hundred years.[8] Darwin often said in substance, "No one who is master of his senses will expect a race to remain pure and true to its species if he does not segregate his animals;" for races and families improve through selection.[9]

A large number of malformations are inherited. In the medical literature there are records of hundreds of family pedigrees in which one or another defect appears in successive generations, especially when the stock has been closely inbred or where the defect is a dominant one. The eugenic program usually gives the impression that our chief concern with human inheritance is related to the elimination of the defective materials which have become incorporated in the species, rather than with the discovery of superlative human materials, and with their preservation and perpetuation. In considering the part that heredity takes in the appearance of malformations, it is interesting to remember that if the new character of a malformation is recessive, in other words if it remains undeveloped in the strains, and an individual be mated with an individual of the opposite sex carrying a dominant character instead, the hereditary factor or gene may become widely disseminated in the human germ material before two individuals, each with the recessive gene for that malformation, mate; one fourth of the offspring of this mating then show the defect. When two individuals carrying the recessive genes for some undesirable transmitted character mate, and one fourth of their offspring show this defect, it is high time to prevent marriage except in most carefully selected individuals. Such perverted characters are often seen among the members of a family who marry almost exclusively in their own circle, inbreeding in fact. The care with which such individuals must be selected for later marriage with other strains is of extreme importance. When the defect is a dominant one, it will appear in one half of the offspring, even if the mating is with an individual without the defect. The other half of the children, who are normal, do not transmit this dominant irregularity, for they have escaped it. In many individuals, however, the defect is not ermanently dominant, and nature with her wide scope of varia-lity is so beneficent that the few individuals carrying this factor fail to show it, or else do so only to a small degree.[8] Many defects can be corrected surgically, and others medically, he all-powerful aid of balanced metabolism. If, then, the s are sincerely altruistic in their endeavor to benefit man-trying to eliminate undesirable inherited potentialities nctions, all praise to them, for they are working in soil.

Here is an illustration in point. Suppose a sick man mates with a woman of good hereditary stock; all their sons and daughters will appear healthy. The daughters, however, carry in their genes the potentialities of disease. In the resulting marriage of one of these healthy daughters carrying these tendencies with a healthy man, there result sons one half healthy, and one half sickly, because they inherit characteristics of the mother's gene for disease. There will be daughters who are healthy because they in turn inherit certain characteristics of the father's germ plasm for health; one half of the daughters, however, inherit the characters of the mother's germ plasm and are the carriers of potentialities. A healthy maternal carrier of disease potentialities receives, from the marriage with a sick man, for instance, sons one half being ill; and the daughters will all inherit the potentialities of the father, while one half inherit the potentialities of the mother. It is plain to see that a sick woman mating with a sick man bears only sick infants. The eugenic program is in these instances of vital necessity.[10]

The loose juggling of that expression, "survival of the fittest," is most unfortunate. This platitude implies that between the groups of totally unfit and of wholly fit there exists a mass of humans who are on the ragged edge of life. As a matter of fact one can never know who are those predestined to die or those predestined to live. Had physicians of long ago never tried to save all lives, many of the world's illustrious personages would have been lost. The most correctly recorded ancestry cannot tell us everything. Nature has never transmitted a perfect organism. Who has not seen a puny infant grow up to be a strong adult both in physique and mentality—or, on the other hand, an apparently strong infant die perhaps from a minor complaint at an early age. Who are the weak, who the strong, one can never know.

Many infants and children have a combined constitutional and conditional characteristic which may be termed a *resistance to disease.* Pediatricians speak of high or low resisting powers, foundation stones or sandy soil on which to build health and longevity. Heredity shows itself often markedly in the variations in the susceptibility or the resistance to disease, due, no doubt, to morphologic or chemical idiosyncrasies of the organisms. Certain strains of plants and animals resist hardly at all the inroads of disease. In the eastern United States the elimination of the chestnut is rapidly taking place, for it cannot resist a certain fungus which implants itself on the bark. If, however, this chestnut is crossed with one from Asia, hybridization over-

comes the difficulty. In the lower animal world, one may find that in certain strains of mice, tumors will grow with great rapidity. Graft a bit of this tumor on another mouse of the same strain and the tumor develops. However, graft a piece of the latter growth upon a strain known to be tumor-resisting, and the tumor will not continue to thrive.

Children react differently to inoculation, even with certain diseases. In fact, the inheritance of disease shows a decided difference in individual resistance between members of the human family. Alexander Graham Bell demonstrated a general resistance lying at the bottom of great longevity. The members of certain families lived to between eighty and ninety years. The general and the special resistance to diseases are, no doubt, due to idiosyncrasies in the chemical constitution of the individual, and thus differ in different individuals, as shown in different blood groups in respect to agglutination.

There are strains in humans which are resistant to tuberculosis, to malignant and benign tumors, which are tolerant of sugar excess; individuals in whom minor effects show only when the endocrine glands are functioning abnormally.[11] The importance of the susceptibility to tuberculosis, for example, is shown in the statistical studies of this infection, in which it appears that husband and wife of different strains living together are less liable to develop an active tuberculosis than they and their children would, had all the same constitution. The child may start out with an inherited resistance, but faulty environment may in time break down that resistance.

Medical men, says Barker, in their studies of the origin of disease, during the past fifty years, have in general become much more interested in the external or exogenous than in the internal or endogenous causes. In the regulation of the former factors, one may well point to the triumphs of modern surgery and to bacteriology, parasitology, immunology, and chemotherapy, in the control of infectious and parasitic diseases.

From the time of Hippocrates down to the present day, physicians have been impressed with the susceptibility of certain children to disease and to their differences in susceptibility, as well as in the rapidity and completeness of recovery from disease or injury, and of differences in reaction to external causes. Why does one child contract pneumonia, typhoid, tonsilitis, respiratory affections, intestinal complications, and various forms of fractures, when another child contracts something quite the opposite or recovers entirely from morbid conditions, while the first child succumbs. Why do certain children in tuberculous

families never get the disease, or if they do contract it get well, while others living in practically the same environment and under the same living conditions, contract it and die. There must certainly be differences in predisposition, either inherited or acquired. The answer to these questions lies in the consideration of a combination of an exogenous and endogenous relationship.

Fortunately, during the past few years, great minds have been working on the study of constitution and condition and their bearing on the cause of pathological irregularities in the child's organism. Data are gradually and painstakingly being accumulated by scientific men, and principles are being established and standardized which are opening up a new era that will aid physicians in preventing and curing ills at present obstinate, thus benefiting humanity in general. Criticism may point to the fact that experimental data on plants and on the lower animals may not correspond to those obtained in the study of human beings. This is certainly true when concerned with the complexities of mind and body in the human race, but a little exploration in the field of biology will show that the basic essentials in both classes are the same.[12]

While the resistance to disease may be considered partly endogenic and partly exogenic in character, there is ample proof that fundamentally it is inherited. The works of Slye, Little, Loeb, and Tyzzer unmistakably show this. The resistance of Brahma cattle to Texas fever, of Algerian sheep to anthrax, may be cited.

It is at least theoretically conceivable that among groups of animals, and undoubtedly among humans, there may exist hereditary differences which tend to increase resistance, such as differences in cellular structure, a greater phagocytic action of leucocytes, a greater power of agglutination, and a larger supply of antibodies.[5] Obviously, quite the opposite condition may be present. There is no denying the fact that critics are not united in this belief. The dissenters believe that a lowered resistance to disease is not at all an hereditary factor, but arises solely from economic pressure in some form, through the sinking of the individual to a lower social plane.[13]

Finally, the prevention and treatment of disease depends on the clinician. His medical education, his clinical experiences, his studies and research are all of vital assistance in diagnosis, in prevention, and in subsequent treatment. Some physicians believe in the supreme efficacy of drugs and medicines in combating disease, and belittle the value of foods

and metabolism. Others, more modern, endeavor to balance metabolism and employ drugs, vaccines, sera, etc., much as an invalid might use a crutch to assist recovery. It is our conviction that many minor and intermediate dysfunctions, perverted traits, and inherited disease states and potentialities may be adequately remedied if proper measures are instituted.

DRUGS AND MEDICINES

Many persons, including some physicians, still cherish a belief in the efficacy of long continued drug medication, not only in acute disease processes but also in chronic conditions. Physicians of other days treated certain symptoms with strongly diluted or highly concentrated infusions and concoctions, and depended upon them almost entirely to establish recovery. Drugs are no cure-alls of organic conditions in the child, and their effect is quite negligible outside their allotted field, which is the conquest of the invading enemy. They have no power to stimulate growth and development. When a specific drug is taken and absorbed, the blood stream carries it or its derivatives to certain organs of the body, in accordance with the idiosyncrasies of that particular drug. Obviously the cells of the organs are drugged and at once try to free themselves of the invaders by expelling them. Consequently cell metabolism is either increased or decreased.

Unfortunately, these drugs may act in a quite different way from that which the cell requires, and then the medication proves disastrous. Hence the administration of drugs, vaccines, antitoxins, and the like is beset with uncertainty. For example, the use of the salicylates in certain rheumatic conditions in childhood is a time-honored custom; yet this drug, in our experience, has not warranted, in many instances, the trust placed in it.

Some children tolerate sodium salicylate, often in large doses, while others react to its poisonous character even with small doses. Acidosis may even be produced in susceptible children by large doses of the drug, particularly if it is unaccompanied by an alkali. Indeed, one observer considers that the treatment of intestinal intoxications with intestinal antiseptics ends in failure. In this respect, salicylic acid has proven of no worth, while B-naphthol, the physician finds, produces, first, a decrease in the intestinal bacterial count, but soon after, an increase. Kaolin gives a similar reaction. Close observation has tended to prove that this preliminary decrease was possibly due to the irritant action of the drug, while the increase followed a secondary in-

testinal stasis which was accompanied by putrefaction, and proved resistant to laxative diets. Diarrhoeas apparently act in a similar manner.[14]

No one can truthfully state that drugs and medicines furnish continuous immunity to the child. Likewise no one can claim that inherited dysfunctions can be cured through drugs alone. Amelioration only can be gained. Drugs given over too long a period may even enhance a particular dysfunction or arouse another in its place. Many dysfunctions of varying degrees of severity which owe their existence to inherited organic impairment are, in reality, potential, rather than completely developed, their presence being verified only by careful observation of the symptoms. In these cases, it can be readily seen that the reaction to drugs, medicines, vaccines, sera, and other therapeutic agencies will differ greatly in different infants and children.

If given sporadically and haphazardly, we gain success in one case, in another, failure. Then drug medication is either proclaimed enthusiastically as a panacea or blamed when not successful. In our opinion, no medicinal agent known can compare in efficacy with the balancing of metabolism. One must admit, however, that many medicinal remedies lose their valuable healing properties because metabolism is at low ebb. If the cell cannot find nourishment of a kind that will enable it to carry on its normal functions and activities, it is evident that an additional burden in the form of a foreign substance can but further handicap its activities, and no possible benefit can result. Therefore, medication, given usually in small doses to begin with, should be accompanied, if not preceded, by a diet as general, as appetizing, as digestible, and as metabolizable as possible.

For hundreds of years we have been seeking a specified drug or panacea for every disease, but we have failed to find it. There is no such panacea in synthetic drug chemistry, and only in the forces of nature can we hope to find this utopia. Salvarsan, proclaimed a specific against syphilis, is specific in only certain forms of the disease. In reality, then, a disease is remediable only through nature's methods.

Physicians inject into the blood stream of children calcium, foreign blood, iron, and antitoxins, where a deficiency of them exists. They use urotropin to aid in cleansing internal organs; they neutralize an excess of acid by means of alkalies; they render bacterial toxins inert, but they kill both pathogenic and histologic cells with the x-rays.

We have no desire, however, to stand in the position of a pessimistic medical Nihilist, for we do not doubt the efficacy

of drugs and medicaments in moderation and in acute cond
tions. However, we question very much whether drugs, ant
toxins, bacterins, sera, etc., can satisfactorily cure any specif
disease forms if employed over too long a period, or if used wher
the cells have been unreasonably impaired or destroyed throug
the original microorganisms or through their toxins. Medicina
curatives can be of value only when there are a sufficient numbe
of cells acting and regenerating normally. And we are confronte
with that never ending question, "How much of a given dru
can we administer with impunity?" [15]

EFFECTS OF DRUGS ON CELLS

Why, then, are the benefits of drug medication so uncertain
when we have been taught to believe that they should be cer
tain? The answer lies within the cell itself. Drugs affect the cell
in many ways; first, they may enter into chemical combination
with the constituents of the cytoplasm. The oxalates, for in
stance, form soluble salts with the calcium of the cells. Strong
solutions of potassium and of sodium hydroxide owe their causti
effects to the fact that they form soaps with the fats and alkal
albuminates from some of the proteins in the cells, and abstrac
water from them. Second, drugs affect the cells by virtue o
their physical properties, for unless a drug is soluble in the body
fluids, it cannot be absorbed and circulate in the blood, no
can it enter the cell unless it is soluble in the cell contents. Cer
tain drugs affect the surface tension of cells in relation to thei
surrounding fluids. Other drugs possibly produce effects through
changes in the electrical states of cells. Most drugs act on cell
only when they have penetrated into the cell contents, althoug
it may be said that certain powerful ones act by altering the
cell's surface only. A drug does not change the specialized func
tion or activity of the cell. True, the activity may be increased
or decreased, but its type remains unchanged. We note this par
ticularly in the cases of strychnine and chloral hydrate.

When the stimulation of a cell is excessive or prolonged, the
cytoplasm become markedly depressed, and later paralyzed, and
the cell is dead functionally. On the other hand, if the child's
organism is, in general, functioning adequately, the cell may
finally recover and ultimately resume its normal function. Mis
erable, undernourished, sickly, and rachitic children may grow
into strong, healthy men and women. The form of stimulation
known as irritation is induced in cells by certain drugs. It indi
cates changes in nutrition and growth in the cell, rather than any

effects on its specialized functions. The intensity of the action of a drug on a cell depends upon the concentration of that drug in the cell, which depends, in turn, upon the concentration of the drug in the fluid surrounding the cell. The power of penetration of the pericellular fluid follows simple diffusion procedures according to the usual physical laws. In other cases, the drug is deposited in the cell in some chemical and physical combination, and diffusion continues until the drug has penetrated the cell and surrounding fluids are free from it.

We may believe that many drugs, like certain foods, have a special affinity for certain cells. Some attack the cells of the central nervous system, others, the heart, and still others, the various nerve endings. Indeed, when a cell exhibits an apparent immunity to the action of a drug, it is probably due to the fact that the drug has failed to penetrate the cell constituents, or perhaps, it is due to the power of the cell to oxidize or destroy it.

The direct or primary affects of a drug can be produced only in those cells with which drugs come into immediate contact. Indirect changes in the activity of the cells or one part of the organism often result through the intermediation of impulses transmitted by nerves, or through changes induced in the circulation and in nutrition, in their effects on structures to which the drug or nutrient is inaccessible, or for which it has no particular affinity.

One finds that a poison which weakens a child's heart may also produce disturbances in respiration, owing to deficiency in the circulation in the brain and at the respiratory centre. Then, there are certain reactions called "salt actions" which result from the physical effects of solutions. Such substances as salts, sugars, urea, etc., are capable of circulating in sufficient concentration in the body, and can produce these actions, but are dependent upon the relative ease with which the solution of the particular substance diffuses into those cells with which it comes into contact. Obviously, depending upon this concentration, serious disturbances in the function and composition of the cells may result from this "salt action." [16]

To summarize, the drug may attack the surface of the cell, it may affect the cell indirectly without entering it, or, again, it may affect the cell in the course of entering or after its entrance. An example of the first may be seen in the astringents, such as the salts of heavy metals, ferric chloride for instance, in sufficient concentration.

Other substances neither enter the cell nor attack the cell

surface, but act chiefly by affecting the concentration within the cell. They either withdraw water from the cell so that it tends to shrivel and become desiccated, or else they cause water to penetrate into the cell so that it swells. If drug medication is too prolonged, these processes cause the protoplasm to disintegrate. A substance, in order to plasmolyze, or disintegrate, must fulfill certain conditions; most cell membranes are semi-permeable to most organic as well as inorganic salts, to the sugars, and to many other substances.

A large number of bacteria do not seem to be surrounded with this form of membrane, and salts pass into them apparently unhindered. A study of the plasmolyzing power of many hundreds of substances has shown that such substances, even of the most diverse chemical character, can enter cells readily, for they have one property in common, they are more freely soluble in fatty oils and in lipoids than in water. Glycerin is a good example, but it enters cells very slowly.

It has long been recognized that certain drugs and chemical compounds have very little effect on the child's organism, whereas others produce a marked reaction when administered under similar conditions. The absorption of medicines and drugs assumes a more important role in infants and children than it does in adults, for their cell activities and body reactions are much more virile.[17] The absorption principle has an important pharmacologic action in pathologic processes.

In children, caution must be exercised in the use of many drugs, for it has been suggested that certain pathologic states are initiated by the absorption of toxins upon the surface of specialized cells, and if these surface layers are not removed, permanent damage to the tissues may be brought about by the inward diffusion of these superficial layers. Also, an extremely thin layer of absorbed material may alter all the properties of the solid so covered, and catalysis has demonstrated that absorption layers are the seat of enormously enhanced chemical reactivity.

As already stated, infants and children exhibit a marked intolerance toward certain drugs, particularly mineral substances, while others show great tolerance toward them. This may possibly be due to a dysfunction of certain organs of one child and, contrariwise, to an improved coordination of all organs in the other. In this question of tolerance and intolerance, heredity and organic environment play a decided part.[18]

There is no doubt that much confusion has resulted in the past from the attempt to transfer the results of pharmacologic

xperiments directly to the practice of therapeutics. In many nstances this has led to pediatric anarchy. The pharmacologist eaches conclusions which appear, from his crucibles and test ubes, to be beyond contradiction. Yet when the physician, luly impressed, applies the knowledge so acquired, he arrives at uite diverse conclusions, and he is at a loss to understand the eeming discrepancy. He therefore views the laboratory work vith skepticism. The pharmacologist works on normal animals, elected for his purpose; the drugs are given usually in large loses and thus quickly reach the organs and tissues to be acted pon. However, in pediatrics, the conditions are almost never hose of the laboratory. The infant or child is not normal and he effects of the medicines upon the child may be, in conseuence, totally different, even under apparently the same conitions.

Often a drug may be employed for the purpose of acting on function or tissue not in itself abnormal, and which through his action may indirectly affect the primary pathologic state, as s seen with the use of laxatives in pneumonia. In many diseases f infants and children, the action to be elicited is a direct one n the diseased tissue itself, and the conditions may vary coniderably from those in animal experimentation; they may differ trongly in intensity and in ultimate effect. Most of the functions f vital organs are complex, in that they involve a number of actors which normally work in harmony. In disease, incidenally, one of these factors may become dominant while others ease to exert their influence. In the mechanism of diuresis one nust consider a permeable membrane, also vessels capable of a ertain degree of constriction and of dilatation, and a volume of lood of fairly definite concentration. When a pathologic conition arises affecting the dilating power of the vessels, diuresis nay be greatly increased, or again, may be entirely absent, one actor having responded more actively or less actively to the rug than is the case normally.

The action of drugs upon the maturing and unstable nervous stem of children may differ markedly from that in adults. bviously, when the adult complains of agonizing pain, we now that very small doses of morphine or of some of its derivaves may bring relief. Similar conditions may exist with a ough. The beneficent action of morphine consists in reducing e excessive irritability of the brain centre to its normal level. n our hands, though, this drug has proven deceptive and danerous. No prophet in the wilderness can utter too strong an vective against the promiscuous use of drugs in children. A

pediatric Moses might be able to extract a very small numbe
of drugs from the pages of the pharmocopeia, and induce us t
study them in fullest detail. What clinician has not noted th
results of drug action on the normal and on the diseased hear
of the child, and observed the many variations in the activit
of a certain drug? Digitalis, for example, may produce a dis
tinct cardiac slowing in a normal child, with an increase o
both the systole and diastole. In cardiac decompensation, how
ever, with a normal rhythm, there may result only a slight re
tardation. It would seem that the vagus centre has either los
its irritability or else it no longer exerts a controlling, modifyin
effect on the heart rate.

Fever lessens the response of the vagus centre to drug stimul
tion, through possibly an anemia of this centre, or from hear
weakness through faulty circulation. Again, one may note th
uncertain action of drugs in the strengthening effect of digitali
upon the contraction of a weakened heart as being more marke
than upon a normal one. Quite analogously, camphor, whic
has an uncertain action upon a normal heart, acts as a stron
stimulant to one weakened, for instance, by chloral. These fe
examples of the uncertain effects of drugs might be multiplie
easily in pediatric practice.[19]

The condition of a child's organism as a whole plays an im
portant role in determining responses to chemical substance
or, in other words, to drugs. Normal digestion, and indeed, th
nutritional state of the digestive system, is a factor of considerabl
value in modifying the action of drugs and of extrinsic and in
trinsic poisons. In the study of the interaction of living struc
tures and chemical substances, the nature of the child's psychi
and physical environment must be taken into account. In con
sidering the chemical composition and the pharmacologic re
action of the pericellular fluid, due consideration must be give
to the blood. When changes in the environment have been arti
ficially produced, the behavior of drugs may be of great impor
Burridge found that the action of potassium on the heart coul
be altered by changing the hydrogen-ion concentration of th
perfusing fluid. Acidity, he discovered, decreased, and alkalinit
increased the effect of calcium on the heart. MacNider believe
that alkali increases and acid decreases the resistance of the kid
ney to anesthetics. According to Zondek, calcium antagoniz
the effect of arsenic and quinine on the isolated heart of th
frog, while potassium decreases the depression which these dru
produce.

It seems easy to believe that in the days of old-fashioned sho

gun prescriptions containing a number of drugs, some of these drugs, not in themselves empirical, might have acted upon histologic structures in such a way that they and their functions might have been rendered pathologic to the action of other drugs in the same group. Therefore a combination of drugs should not be given to a child. To diagnose the fundamental cause of a disease and to obliterate it through simple remedies of proven integrity, and at the same time to strengthen the metabolism, is the physician's responsibility. To employ even well recognized drugs in highly concentrated solution is too daring an act. For example, Salant found that salicylate in a concentrate of 1-2000 in the presence of an excess of calcium and potassium produced irregularity, depression, and even arrest of the heart's action. When a stronger solution of sodium salicylate was used, the effect was even more pronounced. Variations in the amounts of these salts was found to change greatly the injurious action of the drug, for changes may be produced, in part, by a disturbance of the calcium mechanism. While these variations in the reactions of drugs affect their action in adults, the result in children is much greater.[20]

VACCINES FROM FOODS

It may be prophesied that vaccines and sera in the future will not only be of medical but of biological importance as well, for they may be made from foods rather than from living and dead bacteria. New discoveries along this line have already been demonstrated on rabbits, but not as yet on human beings.

Goebel has created the first synthetic vaccine against such diseases as pneumonia, malaria, typhoid fever, and streptococcus infections, from bran, egg-white, and a little sawdust. From sawdust he obtained a complicated sugar derivative, cellobiuronic acid; from egg-white a pure protein. The latter two substances were combined chemically and injected into healthy rabbits. It was found that within a few days the blood of each animal was so immune to pneumonia that when deadly injections of virulent pneumonia germs, enough to kill 1000 normal animals, were administered no evil consequences resulted.[21]

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CHAPTER 8

METABOLISM

FTER Juan Ponce de Leon had conquered Puerto Rico, in 1509, nd had completely controlled and pacified the island, he set ut with three ships to search for that mystic land of Bimini, here, according to Indian legend, he would find waters of mar-elous curative power, the fountain of youth. Had he been ortunate enough to live at a much later period he might have voided that arduous and hazardous journey and learned from ne pages of biological science the answer to his goal of desire.

Metabolism may be defined as the sum of the chemical processes pon which the function, growth, and repair of the cell depend. uch a summary carries no exaggeration. Metabolism is the ell, the cell is metabolism. The cell is protoplasm; thus all its ctivities are protoplasmic and metabolism becomes a collective rm. The process of metabolism comprises the following ac-vities:—

(1) A preliminary stage, or the taking in of food materials.

(2) A chemical transformation by which these materials are orked over into cell substance, or used as sources of energy.

(3) The discarding of products resulting from the chemical ction which are not to be retained within the protoplasm. The aterials to be cast off are either manufactured substances, such enzymes which both plant and animal cells produce and crete, or else waste products like carbon dioxide gas, which is roduced whenever food is oxidized.[1]

FORMS OF METABOLISM

Among the biologic activities of cell protoplasm is one known *basal metabolism,* which is nothing more than those chemi-l processes in the actively living protoplasm which make up the asis of life, and which go on at a fairly rapid rate. To a minor gree there is also a using up of materials and subsequent cessary replacement. Another form is *growth metabolism* in ing things, such as plants and animals, by which new proto-asm is added to that already created. There is also the manu-

facture of non-living materials which are essential to grow
Examples of these are:—the cellulose walls of plant cells, a
the hard parts of bone in animals—non-living substances,
truth, made by living protoplasm in connection with growt
In plant growth, and in many of the lower animals, metaboli
goes on more or less continuously throughout life; but in ma
growth metabolism, except in the skin and in the reproducti
and blood-forming tissues, progresses only during early life a
ends when growth-necessity ceases. In both plants and anim
there are many types of cell aside from those which might
termed growth-producing. Some of these cells are concerned wi
the creation of special materials to be used by certain orga
the saliva is an example.

Under normal conditions the metabolism of the cells is su
that the processes of assimilation and dissimilation balance ea
other in the body. The physiologic properties of the cell a
technically known as irritability, conductivity, and motility.
irritability is meant the ability to cause, in definite manner, t
action of external forces or stimuli. Conductivity is the proper
possessed by living matter of propagating through itself a sta
of activity arising at any point. Motility is the property possess
by certain cells of executing changes of shape which amount
definite movements.[2]

Motion, whether achieved by the machine or the living orga
ism, is dependent upon a chemical transformation in its fu
In the living organism this transformation is known as metab
lism, and, in order to distinguish this particular form from t
chemical processes concerned primarily with fundamental li
or with growth, the collective term, "functional metabolism,"
used. Nervous activity is common to practically all forms of a
mal life; hence our inclusion of the nervous system under th
form of metabolism. We can readily realize that all our feeling
all our mental processes, are dependent upon the nervous syste
Functioning as it does because of protoplasm, the nervous syste
may be looked upon as a force by which every organ and functi
of the brain and body are united.

The source of the child's energy is metabolism. In the huma
organism, as well as in plants, the nourishment taken in must
changed by chemical transformation into substances which m
be used for special purposes. Can we not speak of these for
which keep the machine going, as it were,—the forms which a
associated with the burning up or oxidation of the fuel suppl
as those of "energy metabolism?"

METABOLIC ACTIVITIES

The physiologic activities of the cell are attended by a libera-on of energy which is locked in the food molecules and is eed essentially by oxidation. The energy thus liberated mani-sts itself in three forms; motion, electricity, and heat. These xidative processes, or waste products, among which may be entioned carbon dioxide, urea, uric acid, etc., are discharged to the surrounding medium.

In the scientific nutrition of infants and children, it is well to ear in mind that one important difference between plants and nimals is the fact that in plants the kind of metabolism that esults in the formation of materials predominates over that hich consumes them, while in children the reverse is true. Since ost of the material that is stored in plants has high energy alue, the result of this difference is that, in general, plants ain weight and potential energy throughout the life span. In he human organism, on the other hand, when the adult stage reached metabolism is almost entirely concerned with the onsumption of energy. These facts would seem to indicate that is entirely compatible with Nature's plan to have plants upply sustenance to the animal organism. Hence, when the hysician orders cereals, fruits, and vegetables as important items n the child's diet, he is giving his little patient the benefit f the plants' energy metabolism.[1]

Metabolism is usually considered from two separate, though orrelated viewpoints,—the energizing and the purely chemical. Vhen planning the nutrition of infants and children it would be logical to consider the matter from the maximum or minimum equirement of calory, protein, etc., alone. We must consider lso the biologic, as well as the psychic and physical stimuli. ncidentally, Nature abhors the use of predigested and other oodstuffs, also their transformation into end-products alien o their natural use, except in special cases. Muscle uses carbo-ydrates exclusively for the performance of work. Lactic acid, hich is the real working substance in the muscle, is derived rom carbohydrates. Apparently the child's organism is able in mergency to transform fat and protein into carbohydrates in rder to perform work, though probably with a great loss of nergy.

The interruption of metabolism inhibits all visible phenomena n the cell movements of protoplasm, such as cell division and cell ecretion; but life itself can be preserved for a certain length of

time. In consequence of the fluid state of protoplasm and the instability of the cell stuffs, voluntary events of physical, but chiefly of chemical nature are going on continuously, which aim at a balance of the existing potentials of energy.[3]

Metabolism is the problem, and certainly the secret of life. The various specific cell receptors which take up poisons are not designed fundamentally to serve as poison carriers, but to build chemically the products of metabolism. Thus this assimilation if considered as a purely chemical process which the instability of colloidal chemistry has brought about, and the immunity problem—that goal for which we are ever striving—are basically problems of metabolism.

In studies of growth and development in the child, if one attacks the problem solely from the standpoint of the cell, one finds oneself agreeing with Kirchow in comparing it to a distinct individual, for it provides itself with nourishment, it moves and digests, and even interests itself in longevity. Heredity may be an allied factor in longevity, but it is assuredly a problem of metabolism. Experience, education, and knowledge have broadened and changed the conception of life. Today it is known that physiologic, psychologic, sociologic, and other influences are transmitted directly to the cell. We know that factors such as custom, heredity, adaptability, the activities of the mind, the disposition, speech, etc., by affecting the cells affect the entire organism. It is true that we commonly think of a group of cells as having come into being from a single cell, but it is by no means possible to think of the organism as comprised of cell groups, each with wholly independent functions, for there must be a combined effort, a working together of all groups in perfect harmony, for the good of the organism as a whole.[4]

METABOLISM FOR ENERGY RELEASE

Metabolic energy has already been mentioned in a general way. However, since this form of energy is so important a factor, especially in the life of the growing child, it may be well to consider the subject in greater detail. In both plants and animals the use of food as fuel results in its chemical breaking down and the liberation of the resulting factors, or the release of energy. Carbohydrates and other non-nitrogenous compounds are oxidized directly or indirectly in the various metabolic processes, the oxidation when completed resulting in the production of carbon dioxide and water, in addition, of course, to the liberation of energy. Depending upon the individual child, this energy

nay be used primarily in many ways, perhaps in sports and alisthenics, or, if the child is not permitted this health-giving ctivity, the energy may escape as heat.

Protein metabolism always arrests the attention. Proteins, those itrogenous compounds of carbon, are converted during the ourse of basal metabolism into simpler compounds, such as rea and uric acid, and are excreted in the urine of animals, a rocess not paralleled in plants. Of passing interest are the hanges in carbohydrates as seen when sugar, starch, and similar ompounds undergo a series of processes called fermentation, first reaking down into alcohol and acids and gradually reaching arbon dioxide and water. These processes are due to the ac-ivities of micro-organisms, but are brought about by enzymes which they manufacture.

One is familiar, too, with putrefaction, that process during which nitrogenous organic compounds are broken down to am-nonia and carbon dioxide. The presence of phosphorus, and particularly sulphur, causes the giving off of offensive odors. n this energy release, also, one finds that fats and oils are lecomposed by micro-organisms, enzymes, and lipases, which reak down these fats, first to glycerine and fatty acids, and urther to carbon dioxide and water.

The solid nitrogenous wastes, consisting of proteins, amino-cids, and their intermediary products, undergo successive de-omposition by corresponding bacteria, and end their course as mmonia and carbon dioxide. It is known that putrefaction pro-luced by bacteria in turn produces simpler compounds until mmonia and various sulphates and phosphates are reached, but he exact chemical reactions are not known. Among the many roducts which are broken down by putrefaction are meat, milk, ggs, seeds, etc. While proteins and amino-acids are formed from hese and are eventually reduced to ammonia, carbon dioxide, nd water, there are also intermediate products, such as eptones and albumins. A number of gases are formed, such as ydrogen, nitrogen, methane, hydrogen sulphide, etc. Sometimes he volatile compounds, mercaptan, skatol, and indol, are given ff, the two latter being so vicious in childhood.[5]

As has been stressed, the child's diet should include proteins nd inorganic salts, with particular attention to at least small mounts of sulphur and phosphorus. However, one should not ose sight of the fact that the child's food must contain carbon, ydrogen, oxygen, nitrogen, sulphur, and phosphorus, and many ther inorganic salts, and it is the duty of pediatricians to advise asily digestible and metabolizable foods which contain these

necessities. The living cell machinery wears out with use, ar
nitrogen is one of the elements lost which must be replace
However, for use in the living organism, nitrogen must be cor
bined with carbon, hydrogen, and oxygen, and a simple comb
nation of these is found in the amino-acids. The change fro
proteins to amino-acids is brought about by enzymes. Althoug
some scientists refuse to consider any difference between anim
and vegetable proteins, we cannot agree with their opinion. W
question, too, their conclusions as to the so-called normal die
that is, proteins, 100 grams, 400 calories; fat, 100 grams, 9c
calories; and carbohydrates, 500 grams, 2,000 calories.[6]

PHYSICAL STIMULATION TO METABOLISM

Hill, Campbell, and Gauvain studied the metabolism of chi
dren undergoing open-air treatment, heliotherapy, and balne
therapy, and noted that all these stimuli increased the metabolis
rate. Under the influence of fresh air and sunlight the basal m
tabolism figures were found to be 50 percent above those of th
Benedict and Talbot standards. The metabolism rate of the
children in winter was 20 to 30 percent higher than in summe
They found the rise caused by heliotherapy small compared t
that caused by open air. Some investigators report definite change
in metabolism after ultra-violet ray treatments, others feel tha
the effect is negligible. In Hamburg, Germany, fourteen childre
were studied before and after a two-months outing at the se
shore, but no change in metabolism was noted.

Very little is known concerning the effects of racial differenc
on metabolism. It is known, however, that basal metabolis
depends fundamentally on the food intake and the differen
between the temperature of the body and the temperature of th
air, multiplied by the surface area. Proper metabolism is aided b
environmental agents.

Benedict and Roth found no significant difference in th
respiratory metabolism of vegetarians and non-vegetarians. Krog
and Lindhard are of the opinion that the metabolism is di
tinctly lower if the previous diet has been low in protein. Bene
dict and Smith found that the basal metabolism of traine
athletes averaged six to seven percent higher than that of nor
athletic men. This possibly reflects a higher nutritive plane.

Findings on the influence of sleep on metabolism are somewha
contradictory. Benedict and Talbot mention a marked fall i
metabolism when a patient falls asleep. They find, too, a dro
in the pulse rate and in the respiratory quotient. Loewy est

nates that heart action accounts for about 3.6 percent of the metabolism of man and the respiratory movements for about ten percent. Krogh considers that the kidney metabolism may be five percent of the whole and that the functional activities of the various organs may total 25 percent of the so-called "resting metabolism." It would appear that about three-quarters of the heat produced under basal or standard conditions is derived from oxidations in resting tissues. It is entirely possible that the skeletal muscles are responsible for a large portion of basal metabolism.

Krogh states, "In warm-blooded animals the 'environment' of the cells is maintained practically constant with regard to temperature, concentration of hydrogen ions, salts, oxygen, sugar, and probably other sources of energy. The standard metabolism is a constant which is independent of changes in the outside world, because these changes are always toned down to insignificance by the regulating mechanisms before reaching the cells."

At birth the liver and thyroid are relatively larger than in adult life, and it is quite possible that these have some influence in determining the higher level of metabolism. In childhood the food intake is much greater in proportion to body weight, and we may be dealing with a relative over-nourishment per kilogram of substance. The growing sex glands are also a possible influencing factor.

Many physiologists have expressed the opinion that the higher metabolism of children is due to a specific stimulus associated with growth. Krogh points to the low metabolism during the first few months of life as evidence against a stimulating effect of growth, since growth is most rapid at this period of infancy. This author believes that, "the factor which is most probably responsible for the regular increase in metabolism of young children is the development of the muscular system as such, and perhaps simply the gradual development of a muscular tone." Since changes in the rate of metabolism in infancy occur more slowly than in the adult organism, the reason would seem to be that the organism is adapting itself to a new existence. It has been observed that the adult body cells change their rate of metabolism rapidly under the influence of undernutrition or thyroid extract. In our own opinion, it would seem that, since growth is apparently dependent upon growth impulse, this latter being partly hereditary and partly somatic, adequate food supply and proper environmental stimuli would tend to create a heightened muscular activity, which would, in consequence, increase the metabolic rate.[7]

MENTAL STIMULI

It is well known that the relation of mental activity to metabolism is an important one. The brain comprises only two percent of the total body weight, but it has ten times as large a flow of blood as the same mass of skeletal muscle. The fact that metabolism falls during sleep, in certain cases, is perhaps due in part to a diminished metabolism of the brain. It is to be supposed, however, that excessive excitement at bedtime arouses emotional states in children which tend to raise the basal metabolism.[7]

Many times in these pages have we emphasized the fact that the successful treatment of diseases in infants and children cannot be attempted without an improvement in metabolism. In convalescence one sees a progressive gain in nutrition from an adequate psychical and physical environment. The brain and body comprise a corporate whole, and in mental and physical health is found a harmonious balance between the two. In their treatment this sensitive adjustment must be kept in mind—mental hygiene, in short. The heart, respiratory system, skeletal muscles, and joints, as well as the digestive system and metabolic processes, are controlled by a well-systematized action which is dictated by the rhythmic sense of the brain. All metabolism in the body cell manifests itself in a rhythmic way. The various forms of education are beneficial factors in perfecting metabolism. The influence of music on the child's organic life has been stressed repeatedly by psychologists and pediatricians. Cheerful musical tones tend to increase the pulse rate and respiration, heighten the blood pressure and metabolic rate, and add to the efficiency of the digestive and eliminative power of the intestines. On the other hand, sad music tends to have a depressing effect and to unbalance metabolism.[8]

POTPOURRI ON METABOLISM

Protein is an essential element in metabolism. From proteins are formed the amino-acids, the presence of which are so essential to the forming of protoplasm. Among the organic functions the digestive enzymes are largely dependent upon proteins. According to Burlingame, one could exist and be well nourished on a diet of proteins, for they form tissue and yield energy as well. The Esquimaux live chiefly on a protein diet. On the other hand, carbohydrates and fats alone would be insufficient

or a diet, since they furnish abundant energy but have no tissue building qualities.

Metabolism in plants and in animals differs in at least one respect; in the latter it is often wasteful. It is a well-established fact that in animals much of their metabolism consumes amounts of materials which are theoretically excessive. It is a simple problem to calculate the amount of energy necessary to do a certain piece of work. One can also measure accurately the amount of energy yielded by the burning of a given quantity of food material. However, when a known amount of food is consumed in the body in connection with the performance of a stipulated amount of work, the amount of food used is much more than is required. What is the biologic reason? We do not know. There is a well-established law of physics which states that the total amount of energy neither increases nor decreases, although changed in form. This energy, failing to appear in the performance of work done, must be utilized for another purpose, and the answer is found in warm blooded animals as heat production.

Therefore, in connection with child nutrition, the food ingested must be sufficient to manufacture heat as well as to supply heat loss. Normally, warm blooded animals are maintained at about the same temperature, day in and day out, summer and winter. The temperature of the child will have a tendency to drop below normal if he does not receive a sufficient quantity of the right kind of food. The wonderful heat mechanism of the child's body can be appreciated when it is realized that whether days be hot or cold, pleasant or unpleasant, the body temperature is constantly favorable to metabolic activity.

Metabolism at rest, or basal metabolism, is a study that adapts itself more readily to the laboratory than to the clinic. It is accompanied by a steady waste of the very complex substances of which protoplasm is composed. The proteins, therefore, are mostly lost from this type of protoplasm and have to be replaced constantly. It follows that the composition of the diet must be such that these losses are replaced. It must be understood, too, that the substances in the diet do not correspond exactly with those from which protoplasm is created; the latter must pick, choose, and reject in order to get just the kinds and amounts required. This leaves an accumulation of food materials, even though logically some could be used in basal metabolism.

Burlingame states that healthy, growing boys may eat as much as twenty-five pounds of food in a week without gaining one pound in weight. At the same time, their combined basal and

functional metabolism in no way accounts for the other twenty
four pounds.

The difference between functional and growth metabolism i
that in the former the liberation of energy is the importan
feature. Chief among the substances from which the energy valu
has been exhausted is the so-called waste product, carbon dioxide
water is perhaps next on the list. As the child's cell is a laborator
in which protoplasm is made, the working knowledge of its ac
tivities in their relation to metabolism is very necessary to prope
understanding of the nourishment of the body in health, growth
and maintenance, as well as in disease. Every living cell mus
have access to food to carry on its function, and since a large par
of metabolism is oxidation, large supplies of oxygen must b
available. Also, each cell must rid itself of waste products.

In the higher animals—therefore in the human organism—the
cells are so situated that they have direct access neither to an
oxygen supply nor to an outside region for the discharge of
waste products. This means that provision must be made for the
cell to carry on its function. There are four ways of doing this:—
first, a general transportation system, second, a service for the
preparing and delivering of food, third, still another service for
the delivery of oxygen, and fourth, a service for the removal of
waste.

The structure of a cell determines its processes of functioning
Today, more than ever before, clinicians are interesting them-
selves in the fluid with which all cells are bathed. This pericellu-
lar fluid not only maintains a proper degree of liquid for the
cells, but it acts both as a storehouse for food substances from
which the cells may draw their supply and as a means of waste
removal. The fluid must be renewed constantly in order to sup
ply the nutritive requirements of the cells.[1]

The pericellular fluid when submitted to a changed environ-
ment will respond biologically if treated gently, but will react
unbiologically when treated harshly. If a substance not entirely
inert, one to which the cells have become accustomed, is with
drawn, there is produced a vital, negative change in the chemical
environment. Of course we know that all the processes of life
are derived from the processes of oxidation within the cell. Voit
believed that metabolism is not proportional to the oxygen
supply, yet it is difficult for us to understand how anyone can
maintain that a considerable reduction of oxygen in the respired
air can be without profound effect on the chemical processes o
the cells and therefore on their functional activity. Mosso and
Henderson claim that the reduction of the normal carbon dioxide

ntent of the cell produces marked changes in its functional ivity. Araki and Zillessen emphasized the fact that decreased dation leads to the production and excretion of lactic acid, final result being acidosis. As demonstrated by Koehler, unquist, and Loevenhart, it appears that the breathing of air ficient in oxygen results in alkalosis, followed by a return to normal hydrogen concentration of the blood. If the oxygen ficiency is extreme, acidosis develops.[9]

We have already spoken of the pericellular fluid and its eral functions, among which is the carrying of food materials the cells. We did not mention, however that the organ which kes this constant circulation possible is the heart. When the art is strong and normal, the machinery for transporting the od materials is provided with adequate driving power. However, should a heart impairment occur, it can readily be seen at an important causative factor for mal-nourishment of the dy is at hand. So essential is a proper food supply for the dy cells that the most exacting study of food principles for purpose of establishing an improved blood content is allportant.

Everyone is familiar with the fact that in the highest group animals, the vertebrates, the circulatory system is very extensive d comprises a complicated set of vessels which communicate th the heart. Great vessels leaving the heart finally communie with the tissues through the capillaries, the latter being dely distributed to the vicinity of every body cell. These pillaries unite with the veins, two of which enter the heart. ith the exception of the blood cells and those in the walls of blood vessels, the blood does not actually come in contact th any other body cells. Though the blood transfers nutritive terials and removes waste, it is a completely closed system. e lymph, acting in conjunction with the blood, is of the utmost portance to the cells, for it actually comes in contact with em and provides a medium in which they may function. Those nplex and little understood organic substances, the vitamins, obably neither nourish nor enter the protoplasm, yet no cell n thrive without them.

Protein substances differ from one another in amino-acid cont, in relative proportions of amino-acids, and in molecular nposition.

In considering child nutrition clinically, one differentiates anil, vegetable, and grain proteins, a distinction apparently not lowed in the laboratory. Further, it may be asserted without r of contradiction, that while the first mentioned protein

often places an excessive burden on metabolism, the last two ar much more easily metabolized. In general, if the food protei is broken up into amino-acids, these can be recombined in propo proportion to form body proteins.[1] Incidentally, each one o us can vision that our own beginning was from the fertilized eg which had been activated by proteins. According to Gortne the egg proteins, the ovalbumins, the ovomucoids, the ovaglobu lins, etc., contain all the amino-acids necessary for the formatio of complex proteins such as hemoglobin; but, in addition, eac amino-acid is present in the egg in exactly the quantity whic will be needed later by the growing organism.[10]

While metabolism could not take place without food, neithe could this food be utilized without the aid of absorption fror the alimentary canal, for here it is made ready for the livin cells, and from here it must pass into the blood. Principall along the walls of the small intestine, the food material passe through a thin membrane consisting of a single layer of cells, an then past a second membrane of similar construction which make up the walls of the capillary system. From these intestinal capi laries the food material passes to the capillaries in the tissue requiring it. So perfectly does this mechanism function that th blood does not become loaded with nutritives to an extent whic would interfere with absorption.

One is inclined to forget that respiration is essential to metabo lism. The cell, as well as the body in general, is dependent upo oxygen. This process of oxidation or burning and consequen release of carbon dioxide which takes place within the cell, an thereby supplies indirectly a driving force or energy to the or ganism, is known as *internal respiration.* We know that al higher animals have accessary structures or lungs for the purpos of supplying the blood with oxygen and removing carbon di oxide, which process is termed, *external respiration.* In the in tricacies of respiration, the passage of oxygen from the air o from water into the blood or through the surface of a cell follow the law of the diffusion of gases, which, it may be said, is es sentially the same as the diffusion of liquids. In this manner fresh supply of oxygen is always available, and the diffusion o carbon dioxide is constantly carried on.

While the blood plasma is capable of absorbing about as muc oxygen as water, its capacity in this respect is far less than tha of hemoglobin, a complex, reddish compound containing iro carried to the red blood corpuscles. In the lungs the oxyge combines with the hemoglobin and the latter is transported t the tissue capillaries, hence the surrounding lymph is practicall

free of oxygen. When carbon dioxide is diffused from the cell it enters the lymph, then diffuses through the capillary wall and travels to regions of low tension, eventually escaping.

No organism, plant or animal, can completely escape external influences. All are affected in varying degrees by temperature, moisture, duration and intensity of light, amount of rainfall, fertility of the soil, etc. As a rule, however, animals may be said to be less directly dependent on their physical surroundings. Animals, particularly the higher ones, can better orientate themselves than can plants. The latter may well be considered an index to a region, especially in regard to food supply; for unless the plant can adapt its growth of roots, stems, and leaves to its location it must perish. Possibly the greater ability of the animal in adapting itself to a new environment is heightened by the fact that the animal, in contrast to the plant, not only has a flexible body, but can move about. What is more, the higher animals, with their developed sense organs, can more readily accept changes. This mental quality no doubt influences metabolism, for it brings with it cognizance of a desire for food and therefore increased appetite juices.

Higher animals are made up of groups of cells in which specialization has taken the form of intensifying the property of irritability, a requisite to the cell, at the expense of other functional properties of protoplasm. The cells of the sense organs carry on a regular basal metabolism, but apparently have no functional metabolism. This is seen in the alteration of the state of protoplasm resulting from a stimulus, but after the disturbance has passed, the activity of the sense organs seemingly comes to an end. The sense organs of the body, both internal and external, located within or without the body, depend upon stimuli for cell metabolism. Hunger, thirst, and fatigue, as we have tried to show elsewhere, are important reactions, for without them there could be no ordered metabolism within the cells. Then, too, the contact senses so necessary to the life of the infant —touch, temperature, pain, perception of form, image formation, smell, hearing, sight, perception of color and of distance—all make their impressions upon the activities of metabolism.

Through the combined action of a nervous and chemical correlation, the child develops symmetrically and its body processes perform their functions harmoniously, making the necessary adjustments to their environment as time goes on. A failure of this adjustment impairs efficiency and may cause injury, disease, or death. A detailed exploration into the workings of the cell is imperative, for not only must the caprices of one group of

cells be studied but also those of several groups, each demanding its own particular nutrition and functions. If the cells which make up the heart muscle do not function properly, the circulation of the blood is impaired. If the cell groups underlying the structure of any other organ become disordered, the organ fails to respond normally. In active practice, one often stumbles across a group of diseases, metabolic diseases as we call them, in which the hormone control is impaired, or where there is a disturbance in nerve control. These and many other pathologic conditions are the result of inadequate nutrition and faulty environment which in many cases have affected the parents as well as the child.

Infectious diseases are the result of a serious maladjustment arising from the struggle for existence of competing organisms. In order to combat these invading enemies, the cell's nutritional life should be strengthened. Balanced metabolism is to us the piéce de resistance in the art of healing. To understand fully what is meant by this term, it is necessary to recapitulate. Briefly, the biologic activities of the cell are:—the taking up of food materials, the utilization of them, and the discharge of waste products. When these activities function in the perfect manner intended by nature, the result is balanced metabolism. Should a disturbance of any kind whatsoever occur which causes any deviation in the mechanism, the metabolism becomes unbalanced. In most diseases both the amount and character of metabolism is altered, in which case we speak of unbalanced metabolism.

Fortunately, a state of disturbed metabolism soon becomes apparent through pathologic symptoms. In these bodily manifestations which proclaim a disordered metabolism, the fundamental cause of the disease may be recognized. The healthy body of the normally functioning child has certain characteristics known alike to laity and physician. For instance, the heart in the infant or child is a reliable health index. If, over a somewhat extended period and covering more time than unusual activity would account for, the heart beat becomes much faster than normal, or even much slower, disease symptoms are definitely indicated.[1]

Let us consider for a moment the symptoms which are indicative of a disturbance in metabolism. In fever there is a whipping up of chemical activity which causes the materials taken up by the cells to become depleted more rapidly than usual. At the time, chemical processes within the cells go on more rapidly than is normal and there is a consequent increase in waste material. While it is true that the temperature of the body may rise to feve

point without actually increasing the metabolic rate, there is, in the vast majority of fevers, an underlying increase in basal metabolism. Common to practically all fevers are the symptoms of rapid body wasting, symptoms of metabolic unbalance, hot dry skin, headache, malaise, etc. When, in some diseases, there is a lowered body temperature, a decreased metabolic activity coexists with a resultant lassitude and a slow heart action.

There are many symptoms which are due to alteration in the character of metabolism. In older children, particularly girls, there are nervous conditions, accompanied by various aches and pains, and called rheumatism for want of better nomenclature, which show a character alteration. Vitamin deficiencies or disturbances of hormone control bring about metabolic changes, and are often difficult to handle, since they are caused by hyper- or hypo-endocrine conditions. Infrequently one finds impaired nervous control in girls around and beyond puberty. In some of these cases there is an actual destruction of nerve tissue or an alteration within the nerve cells. One may see an example of this destroyed nerve tissue in infantile paralysis. There are also what may be called psychoneurotic patients, who suffer from various impairments resulting from abnormal metabolism brought about by mental stress, due to the strain of modern economic conditions, unhappy home life, etc.

Nor must one forget that equally dependent upon the sound mechanism of functional metabolism as affecting the nerve cells are the higher brain qualities, such as awareness, association, volition, appreciation, reason, consciousness, the emotions, etc. Even a slight metabolic disturbance may cause perversions of them. In the child especially, a disordered metabolism, even though of no great extent, may affect the emotions to the point of causing the changes in body function seen, for instance, in hysteria and in uncontrolled nervous excitement. The nervous interactions which constitute mental functioning are very delicate and complex. As has been pointed out, the physiologic basis of nervous disorders lies in a disturbed metabolism of the nerve cells. At the age of puberty, especially in girls, a great inpouring of sensory stimuli may seriously disturb the intellectual and emotional states, a condition in which psychotherapy may be of great value.[5]

BASAL METABOLISM

Basal metabolism may be considered as the sum total of all the vital activities of the organism in repose; a minimum metabolism

unaffected by extraneous factors. This form may be expressed in terms of heat produced, or of gaseous exchange incidental to heat production; and using this basal metabolism as a standard the effects of super-imposed factors may be measured. The procedures necessary for establishing the basal metabolic rate are somewhat detailed, including a laboratory and various equipment for making tests which require the specially trained technician. The requirements for the determination of the test are even more exacting.

(1) There must be muscular repose.

(2) There must be no ingestion of any energy-producing foods such as the proteins, which increase metabolism by stimulating the cells to greater activity. It can be seen in this relation that differences in dietetic habits, times of eating, and stomach capacity may interfere in the determination.

(3) Sleep is a great factor in determining basal metabolism, particularly when the subject is asleep within a respiration chamber.

(4) The temperature for the subject must be favorable, neither too hot nor too cold.

(5) There must be an absence of psychologic disturbing factors, such as fear, apprehension; and of physical factors, as noises, ringing of bells, harsh voice of operator, scuffling of feet, etc.

(6) The tests had best be made, if possible, before breakfast, when there is no food in the stomach or upper intestine.

Owing to the multiplicity of factors involved, the most experienced scientists find difficulty in determining a normal standard for basal metabolism. A few of these disturbing factors are; age, sex, weight, height, body surface, protoplasmic activity, living conditions, climate, nutrition, and seasons of the year. Races, countries, and even specific regions are known to have different basal metabolism rates. Undoubtedly certain environmental peculiarities, the ingestion of large quantities of animal foods, and the endocrinologic functions, particularly the thyroid, have a definite influence. Clinicians know, too, that basal metabolism is affected by certain organic dysfunctions such as cretinism, idiocy, psoriasis, and hyper- and hypo- thyroidism. Also there are the disturbances of puberty, of malnutrition, and of acute thyroid enlargement.[11]

BASAL METABOLISM IN HEALTH AND DISEASE

Inevitably interwoven with metabolism, of whatever classification; basal, clinical (or balanced), etc.; are the carbohydrates,

fats, proteins, inorganic salts, and vitamins, the latter of course contained in many foods. From the standpoint of oxidation, these various foods receive similar treatment. DuBois quotes Richardson in regard to the importance of oxidation in connection with energy output of the animal organism. In the dietary treatment of disease it is essential to know the total expenditure of energy and the contribution of the proteins, fats, and carbohydrates. For this purpose an estimate of the oxygen consumed and the carbon dioxide given off is invaluable.

The difficulty of the laboratory test for basal metabolism undertaken in infants and small children has already been mentioned. Their almost constant movement when awake and the ever-present possibility of crying are two of the difficulties encountered. However, clinical work with metabolism proves much more satisfactory and more elastic, and really remarkable progress will reward the patient individual.

Studies of basal metabolism are also hard to obtain in older children, owing to the difficulty of keeping them quiet. Generally speaking, they are quite only when asleep, and they sleep quietly only when their stomachs are comfortably filled with food. This food tends to raise metabolism above basal level and sleep tends to depress it. Talbot states that, "the metabolism during puberty will have to be studied further before any standards may be accepted." For that matter, the question of metabolism just after puberty has not yet been settled. These periods offer many difficulties to the pediatrician in regard to nourishment and healing, and are a problem from the standpoint of the psychic and physical welfare of children. This is especially true in the case of girls. At this period, also, there are apt to be various disturbances in the endocrine glands. Talbot has stated that there are a number of children with enlargement of the thyroid during puberty, and a distinct tendency toward an increase in metabolism. In all these observations, investigators find their figures to be at variance with those quoted by others. For instance, Sonden and Tigerstedt found that the carbon dioxide excretion of boys was greater than that of girls. Benedict and Talbot found no great differences between the sexes in the matter of heat production, at least during the first year of life.[7]

BASAL METABOLISM IN THE NEWBORN

In studying metabolism in the newborn, we begin at its earliest biologic sequence. Hasselbalch, some years ago investigated the metabolism of newborn infants and found that the respiratory

quotient of the child at birth was about unity, which indicates that the earliest source of its energy requirement is derived from stored glycogen. This would indeed indicate a congenital "throw over" of energy.

Benedict and Talbot announced that in 46 newborn infants 80 percent showed a metabolism which was within six percent of 640 calories per square meter per day and per kilogram of body weight. Forty-eight calories is given by them as the minimum rate of metabolism. It was shown that crying during one percent of the time not only raised but doubled the metabolic rate. If, instead of giving a small amount of milk before the experiment, a larger amount was given, the metabolic rate was increased from seven to ten percent. The heat production may be raised forty percent, but of course the amount of energy expended in crying will vary according to the infant, and too, the crying may be stimulated by hunger.[12] Hasselbalch has demonstrated that the basal metabolism of the newborn infant per kilogram is hardly greater than that of the adult. From the standpoint of surface area, this means that the metabolism rate in the newborn is much lower than in older infants and children. The same author found the respiratory quotient to be very high, indicating that the infant is metabolizing stored glycogen during the first few hours of life.

Independently of the above observations, Bailey and Murlin published their results of studies, and estimated the basal metabolism of the newborn at 1.7 to 2.0 calories per kilogram, a figure well above that of the average adult, who produces about one calory per kilogram per hour. According to Meeh's formula, the metabolism for children is 25 calories per square meter per hour, being less than that for adults. One realizes; however, that metabolism is not completely established in the infant during the first few days.[7]

The early experiments of Rubner led him to conclude that, although the metabolism of an infant weighing four kilograms was the equivalent of 422 calories a day of an adult weighing forty kilograms, or 2,106 calories, yet per square meter of surface the metabolism was the same. Camerer showed that a breast-fed infant of nine months may ingest 480 calories in the milk, produce 420 calories in metabolism, and add 60 calories to its body or fifteen percent of the energy content of its diet. In his experiment forty percent of the protein intake was added to the growing organism.

Rubner and Heubner made a respiration test on a child seven

and one half months old which was nourished on modified cows' milk. The intake was found to be 682.8 calories, the metabolism, 593.2 calories, which left 89.6 calories for addition to the child's organism. It is of more than passing interest to realize that a child's appetite determines the amount of food normally necessary to cover the energy requirement of the body and leave a small additional amount for development.

"In fact," says Lusk, "a reduction of fifteen percent in the intake of food would bring the child's growth to a standstill." Heubner believes that the average normal infant requires 100 calories per day per kilogram of body weight for normal nutrition during the first three months of life, 90 calories during the second three months, and 80 calories, or less, thereafter.[12]

Even the metabolism of premature infants has been investigated, studies having been made by Talbot, Sisson, and their associates. Their series included twenty-one babies ranging from four to ten days. The weight remained stationary, after which there was a satisfactory development. The heat production was found to be extremely low, an added indication, perhaps, that during the first few months of life, both premature and normal infants should remain in well heated surroundings. The low heat production was found to increase with age and more extensive activity, plainly showing what we have already discovered, that infants should not be hampered in their first movements by improper clothing or other impediments. Muscular activity was found to increase metabolism as much as forty percent. In considering the relation between caloric intake and growth, it was observed that there was no increase in weight until the premature babies were able to digest about 200 calories a day. The loss of calories in the excreta was estimated at about ten percent. This loss of the food intake was sometimes higher. In their studies of premature infants, Marsh and Murlin found that they produced on the average of 6.48 calories an hour or 26.25 calories per square meter per hour, this being ten percent lower than the figures for babies born at term. It is interesting to note that the same authors point out that crying doubled the rate of metabolism.[7]

UNDERNUTRITION IN RELATION TO METABOLISM

The question of undernutrition is an important factor in many clinical problems. According to DuBois, there are few diseases in which the diet at some time or other is not restricted, either

voluntarily by the patient or intentionally by the physician. The resulting diminution of metabolism may therefore favor a similar tendency in the disease itself, or it may partially neutralize a tendency toward increased metabolism. It becomes increasingly apparent, not only in health but in disease, that food must be given serious consideration. It must be studied from the aspect of biologic worth, digestibility, and metabolic value, the latter being essential, because of necessity of maintaining, as nearly as possible, a proper balance.

During the distressing economic period of 1932, the physician found malnutrition staring him in the face from all sides. There was a disastrous loss of food storage in children, with a marked excretion of ketones, minerals, creatin, and creatinin, also a decided depletion of glycogen storage.

Gamble, Ross, and Tisdall, in their study of the fixed bases of fasting epileptic children, have been able to show that body water is lost not only on account of the destruction of protoplasm, but also, in the early part of the fast, from a reduction of tissue glycogen, causing a decrease in cell volume. Smaller children probably lose much more protein per kilogram of body weight than do larger ones. It has been estimated that eighty to ninety percent of the calories are furnished by fat until the fat stores are depleted, then the protein is consumed in greater and greater proportions until death ensues.

On the other hand, extraordinarily severe measures do not rid the child completely of glycogen. The protein cleavage is a continued source of glucose, and this may be oxidized or partially used for storage or perhaps transferred temporarily into fat. Thus does nature provide adjustments for her mechanism. Also, the amino-acids derived from the breaking down of the protein of one organ may be used for the regeneration of another.

Wilson, Levine, and Rivkin have shown that fasting children develop a ketosis with a higher respiratory quotient than is the case in adults. The extent of this ketosis is probably determined by the relationship between the carbohydrate derived from the protein and the total fat metabolism. Ordinarily there is no danger from the loss. If, however, the starvation is the accompaniment of some disease which either increases the total metabolism or renders the patient more susceptible to the effects of the ketones, the results may be disastrous. From the clinical standpoint it would be highly interesting to note the effects of small amounts of carbohydrate foods in reducing this ketosis. Notice the large amounts of chocolate and candy eaten by children.

Normally the body has large stores of water. Under conditions

such as diarrhoea, diuresis, fever, sweating, and excessive protein breakdown with large urea formation, the water loss from the body is increased. Malnutrition is much more spectacular in children than in adults and there is tendency for the metabolic rate to be high instead of low. This rate ascends much above the usual both as to weight and surface area and there is a tendency for the total calories per day to be lower than in the normal child of the same age. Talbot ascribes the increase of metabolism per unit of body mass to a loss of inactive fat and a relative increase in active protoplasm. Boothby and Sandifor ascribe the increased metabolism in illness to the same factor which caused the disturbance. According to Blunt, Nelson, and Oleson, this tendency toward increased metabolism with undernutrition seems to extend to the ages of eight to twelve years. Wang, Kern, Frank, and Dunwiddie observed a moderate increase in undernourished children from four to thirteen years old. They were of the opinion that these subjects were probably deficient in their fat storage, but that their actual tissue metabolism still approximated that of normal children.

In all forms of cretinism the basal metabolism is low, and it has been found that thyroid extract greatly relieves but does not entirely cure the condition. It is generally admitted that the level of basal metabolism is the best guide to an understanding of the activity of the thyroid gland. We do not consider that a statement concerning a laboratory test should be accepted blindly, since difficult forms of technique and possible errors create limitations. We know that there is a wide variation in the daily metabolic activities of certain children. At the same time, one may feel secure in saying that in every disease there is a marked tendency to a wide variation from the typical which occurs in individual children and there are few hard and fast rules in diagnosis. It is very seldom that one should allow any single symptom or laboratory test to outweigh one's diagnostic experience and ability. A slavish adherence to basal metabolism as a diagnostic index is by no means advisable. In the first place, tests do not always reveal a true metabolism, and even if they did, a correct diagnosis cannot be assured from metabolic rate. Cretinism is a familiar example of this fact. Moreover there are cases in which a disease is accompanied by a low metabolic rate, in direct contradiction to a typical expectancy.

Examples of these apparently contradictory metabolic rates abound. Many children nearing maturity who are suspected of hyperthyroidism fail to show an increased metabolism. A diagnosis has been made more than once of exophthalmic goitre

which did not exist. Cases of irritable heart or neuro-circulatory asthenia have been diagnosed as hyperthyroidism. Crile considers a basal metabolism test of value, but does not think it proves an existent hyperthyroidism. It is a valuable aid in a differential diagnosis of nerve-wracking borderline cases, but of little assistance in the prognosis of this dysfunction. Generally speaking, the effects of the endocrines on metabolism in children seem very uncertain.[7]

THE BASAL METABOLISM OF UNDERWEIGHT CHILDREN IN GENERAL

Blunt, Nelson, and Oleson made metabolism determinations on twenty-eight children, mostly underweight, which showed that the basal metabolism of sub-weight children tends to be higher than that of the normal child. It is one of nature's prodigious efforts to balance metabolism with the biologic needs of the organism as a whole. The excess metabolism appears, in some cases, to be as high as forty percent above that read from the curves given by Benedict and Talbot in similar studies. In most cases observed, the metabolism was found to be not only higher than the curve, but higher than the highest observation of the child of similar weight from which the curve was drawn.

The average percentage excess for underweight children living in a certain health school, compared with those mentioned by Benedict and Talbot of the same weight, was 22 for the total calories per square meter. There is, however, much specific information on the basal metabolism of underweight children that has yet to be published.

Some of the infants observed by Benedict and Talbot were underweight, but in general showed a higher basal metabolism per kilogram or per square meter than the well nourished prototypes. This difference is probably due to a larger proportion of active protoplasmic tissue and a smaller proportion of fat in the underweight infants.

Murtin and Hoobler have drawn similar conclusions. It is unfortunate that only a few isolated observations of basal metabolism in underweight older children have been found in the literature. Such material as is available does not seem to be sufficiently voluminous for use in drawing definite conclusions.[13]

BASAL METABOLISM OF GIRLS

Data have been accumulated by Blunt, Tilt, McLaughlin, and Gunnon, covering observations made on a group of girls. Girls

lend themselves more readily to studies of this kind than do boys, since not only are their biologic needs greater, but mildewed social and environmental customs enforce greater restrictions. Forty-six girls were studied, ranging in age from eight to eighteen, the majority being between nine and thirteen.

Their determinations were precise in the case of twenty-two of the girls, for they repeated the basal metabolism tests the second year, and on fifteen of them the third year. It was found that in the group of girls ranging from nine to thirteen years, the total calories per twenty-four hours increased steadily from 1084 to 1437, the calories per kilogram decreased almost equally and regularly from 36.6 to 30.2, while the calories per square meter decreased from 43.4 to 41.0. Girls of unusual build tended to have a different type of basal metabolism from those of average size.[14]

METABOLISM TESTS

As has already been remarked, basal metabolism tests require elaborate technical handling. In addition, it has been proven that results from these tests, once considered to be conclusive evidence, are often not reliable. One is given to understand that in the average laboratory basal metabolism tests on children are taken in the morning, twelve to fourteen hours after the last meal, with the little patient lying motionless. Observation figures may be low, but the figures would be still lower if the tests were taken after a prolonged period of under-nourishment, or even immediately after a profound sleep. If the findings from these tests are reasonably constant, it is because they have been made from the same individual or from similar individuals of the same species.

The temperature of normal individuals shows surprising uniformity, the pulse rate and blood-pressure do not present great variations. In the blood there are comparatively small changes in the hemoglobin and cell count. The glucose and chloride content under standard conditions are fairly uniform and the hydrogen-ion concentration is fixed within narrow limits. However, the factors of age, sex, size, etc., must also be taken into consideration.

Basal metabolism conditions cannot be held for more than a few hours at a time. Modern experimental periods are from ten minutes to two or three hours, and it seems rational to use the hour as a standard. The accuracy of the testing procedure may be checked from time to time. Having determined the constancy of

the metabolism rate in a single individual, it is important to compare the rate in different individuals. The examiner is able to base comparisons largely on the total heat production, but it would be obviously erroneous to compare a large person with a much smaller one, since the former would have an increased metabolism rate. On the other hand, were we to speak in terms of calories per kilogram, the smaller individual would give the higher figure. It is true that groups might be selected having identical age, stature, and weight, but this would be an almost impossible task. Indications are that the most satisfactory basis for comparison is the heat production per square meter of body surface. Metabolism is known to be consistently high in children, a possible indication that nature wishes to heal through foods and environment.

In 1915, DuBois studied some boys with the Sage calorimeter, and grouping his findings with those of previous investigators, showed the sudden rise in metabolism during the first year in life, the peak in early childhood, and the gradual decline until the period of growth was ended.[7]

BALANCED METABOLISM

In the transformation of a miserable, sickly child into a happy, healthy one, we cannot stress too strongly the part played by the balancing of the metabolism of the organism. The pediatrician's conception of balanced metabolism portrays a general somatic setting of a superior type, with only minor inherited or intermediate dysfunctions, disease potentialities, and traits. This almost perfectly balanced metabolism would necessitate almost flawless physical and psychic stimuli and an abundant supply of varied and adequate foods, physiologically digestible and biologically metabolizable. The cell metabolism would utilize all the nutritive end products of natural foods.

In the progressive balancing of metabolism, one may find in the organism a tendency to compensate inherited and somatic deficiencies, or he may find serious dysfunctions and disease potentialities. However, nature has so planned that foods divergent in character harmonize in nutrition, and thus proper metabolism is brought about. It is our contention that in the normal physiologic mechanism cell metabolism is best achieved by utilization of the end-products of nature foods that have undergone a biologic transformation en route, rather than of foods that have been either partly or wholly predigested by artificial

neans. In our experience we have found usually no cell metabo-ism so badly deranged that it could not utilize at least a small mount of such natural end-products.

There can scarcely exist in the organism a harmony between oods prepared by nature and those prepared artificially by man. t would seem then that food end-products prepared by nature ontain fundamentals of a more natural constitution which ender them of greater vital importance to the cell. The inter-lependence of foods is one of nature's phenomena. The ability of the child's organism to metabolize fats, for instance, is in some vay dependent upon the adequate supply of physiologically avail-ble carbohydrates without which ketosis may result. More or less lefinite ratios must exist in the ketogenic and antiketogenic actors in metabolism, or the appearance of acetone substances annot be averted.

Sugar, for example, is prominent as the antiketogenic or ketolytic substance in nutrition, and the effect of this carbo-hydrate in preventing or abolishing ketonuria is believed to be he result of certain definite chemical reactions in the child's issues. We consider natural brown sugar the best form for the nutrition of infants. Synthetic and predigested foods interfere with cell storage and cell wastage, and proper metabolism is not possible unless the storage and wastage go on apace. The fact hat nature strives for a harmonized metabolism is illustrated in starvation, where the sugar content of the blood is maintained at the normal level despite the lack of an exogenous supply. Under such conditions the blood sugar may rise because of leposits of glycogen in the body; and proof exists, too, that sugar nay arise endogenously from the amino-acids which result from a protein breakdown, as well as from glycogenolysis.

It is perhaps possible for the child to live for a time on the end-products not derived from pre-formed foods, but the actual length of time is problematical. On the other hand, Osborne and Mendel, in numerous experiments with foods containing various proteins, meat residue, casein, edestin, egg albumin, and actalbumin, as well as various proportions of fats and other essentials, but without pre-formed carbohydrates, secured good growth. They found that even when the protein was abnormal n its amino-acid makeup, some growth was recorded. So in-geniously does nature utilize a limited food supply within the body that it has been proven that animals may exist on diets onsisting essentially of protein and fatty acids.[15]

The great importance of ordered metabolism may be seen

microscopically in the development and consistency of the teeth as well as in many other organs and tissues. One of the most common ailments with which the physician comes in contact is constipation, a disorder which carries with it dangerous sequelae. In practically all cases not complicated by more serious disturbances, the condition can be corrected by a proper ordering of metabolism, by the drinking of water and fruit juices, by the ingestion of foods containing cellulose, which add nothing to the body economy but supply laxative principles, by taking sufficient enjoyable exercise, and by emptying the bowels promptly. Plain water has been added to the milk modifications of very young infants since time immemorial.

Water is necessary to metabolism but is of no nutritional value. Very young children should not be given water with meals, for they have a tendency to drink too much. Only enough should be given to soften the solid contents of the food. The young clinician is apt to forget the effect of comparatively large amounts of water, soups, or other fluids taken at meal time without a balancing quantity of bulky, solid food. Particularly if the liquid is warm, the gastric glands are too extensively depleted of their secretions, and as a result both liquid and solid foods pass into the small intestine without having been properly cared for in the stomach.[2]

With a perfectly balanced metabolism all organs and tissues function at their normal capacity and in complete harmony, but if long unused they undergo retrogressive changes which reduce them to rudimentary stages of development. A familiar illustration is the shrunken muscles of the howling dervish. Use increases the size and strength of organs as it does of muscles.[16] All nature strives for balance; even the tiny cell requires it in order to carry on its work.[17]

ADJUSTMENT OF ORGANS TO THEIR ENVIRONMENT

It is difficult for the average mother to realize that the very life of her child, its present and future, its health and happiness, even its love, loyalty, and affection are dependent on harmony between its body and the psychic and physical forces surrounding it. Nutrition means nothing without these stimuli, just as oil, water, and gasoline mean nothing to the motor car without the additional stimulation of the electric spark. Indeed, it is to be expected that the mother can not appreciate the fact that the development of the organs of special sense, taste, sight, smell,

touch, and hearing, and the system of muscles, bones, joints, and organs of locomotion are but the ultimate achievement of a food-getting mechanism, resting fundamentally on the power of all protoplasm to respond to certain outside influences and to execute forcible movements by the utilization of energy liberated from food. The brain and the nervous system likewise are to be included in this mechanism of the adjustment of the child's body to its surroundings, and in a similar adjustment of its various organs one to another.

As we have already pointed out, the basal products of nature may be relied upon for practically all of human nutrition. Protoplasm is formed in much the same way in plants and animals, and its consistency resembles that of egg white, being neither solid nor liquid, with either no color or a slightly yellowish appearance. Some kinds of protoplasm appear clear and transparent, and are homogeneous in structure, while others have a foamy constituency, resembling soap suds.

In the study of balanced metabolism and environment, we are again reminded of the many characteristics of protoplasm; first, the power of growth, waste disposal, and repair; second, the power of utilizing foods and liberating energy from them; third, the utilization of this energy in executing forcible movements and carrying out certain chemical reactions in the manufacture of other substances; fourth, the power of stimulation, conduction, and response; fifth, the power of automatic division and reproduction. These activities of protoplasm must be borne in mind constantly, for, in friendly relationship, the cells have the responsibility of rehabilitation and of rejuvenation.

In this similarity between plant and human metabolism, we see that in the formation of plant food the energy of sunlight is locked up in the chemical compounds of sugar and similar substances, and when these are used as food by the protoplasm there takes place a decomposition and consequent liberation of energy.[1]

THE NERVOUS SYSTEM IN METABOLISM

The cells of the body are controlled and regulated to a considerable extent by nerve impulses, conducted by specifically evolved structures. These nerve actions, conscious or unconscious, cerebral or vegetative, are of great importance in the vital phenomena of life, whether normal or abnormal. The involuntary nervous system controls the heart, stomach, intestines,

and kidneys, as well as the varied processes of the unconscious life. This involuntary nervous system is again divided into two beautifully balanced systems; the sympathetic and the vagus.

The nervous system has much to do with the establishment of the normal nutritive stability of the cell units. It follows, therefore, that a tendency toward the acid side of the acid-base balance as directed by the vagus, and the corresponding leaning toward the alkaline side by the sympathetic, might well become very potent influences in maintaining or disturbing the normal cell balance, and, in consequence, the growth, development, and function of the organs. For instance, certain elements such as sodium and potassium increase sympathetic action and also increase the permeability of membranes as well as the conductivity and the dispersion of colloids. On the other hand, calcium and magnesium increase the action of the vagus, which decreases permeability and conductivity and favors the coalescence of the colloids. According to Holbrook, diseases may be placed in two neurologic classes; first, those due to the vagus preponderance, and second, those due to the sympathetic preponderance. Blood pressure is an illustration of the latter.[18]

THE GENERATION OF ELECTRICITY

One of the interesting points in a biologic study of nerve impulses is the essential factor in cell maintenance of continued balance between acidity and alkalinity, for a loss of balance within the cells means death to the organism. It is quite possible that the maintenance of this balance is found in that form of electricity which is created through constant chemical action and which is generated somewhere in the tissues of the body, and that this electricity is in some unknown manner connected with normal life. So absorbing is this phase of the subject that many able men, notably Crile, are now turning their attention to it.

It may be that life is dependent in part upon succession of chemical changes in the body, but these changes must insure certain reactions or decompositions which will develop electricity. Certain conditions must be present also which permit the storage and conduction of electricity. The colloids of the body are neutral and without potentiality until they are vitalized or charged by electrolysis. The inorganic salts are very important in metabolism, in that they supply these electrolytes with potentiality, although they compose only about two percent of the body weight. The relatively acid cell with its semi-permeable membrane, which exists in an alkaline medium, is dependent

pon these salts for the development of electricity and thus for he continuous activities of the child's life. This point should be emembered in preparing milk modifications for infants.

Further biochemical study discloses the fact that every living ell of the child's body has an acid colloid, the nucleus of which s separated by a semi-permeable membrane from the alkaline ytoplasm, thus forming a complete electric cell with an electric otential existing between its positive and negative poles. This otential, Crile believes, is maintained by oxidation. Cells living nder biologic conditions are adapted to the accumulation of lectric charges. If the electrical capacity of the cells of an verage man is equivalent to that of a Leyden jar 0.3 millimeters n thickness and having a surface area equal to the average city lock, a physicist might be able to compute similar averages in he cells of the child's organism. This gives one a dramatic idea f the electric energy of which the body is capable. The dependnce of this energy on the sensitive balance between acid and lkali suggests the great importance of food intake, digestion, unctional metabolism, oxidation, waste disposal, and the many ther factors involved in metabolic balance.

These thoughts imply that potential energy may become inetic and may develop remarkable manifestations in the nuscles, nerves, and mentality. Under the adverse conditions of nproper food and environment, fatigue and exhaustion are kely to result. In connection with the power of the cell to ccumulate and store up electricity, there may be considered the ossibility of storing up potential energy, which, however, may ater become kinetic through radium, the rays of the sun, or the se of the quartz lamp in the physician's office. Following these nes of reasoning, the fundamental basis of an acquired disease nay be considered only a disturbance of the physico-chemical rocess, in fact, a disturbance in the cells of an affected tissue hich causes a break in the acid-alkaline equilibrium. There esults a profound nutritional unbalance, an invasion of the ytoplasm by some incompatible albuminoid particle, the deelopment of an antibody, and a precipitation caused by the ombination outside the cell of this antibody and an antigen. here follows an obstruction of the capillaries plus a vicious cle of further nutritional embarrassment, which is possibly a isturbance in the electric potential of the cell, and a sudden nange of energy to a kinetic state. It is quite possible that a ombination of many of these changes occur in the cells of the fected part.[18]

ACID AND ALKALI BALANCE IN METABOLISM

In a study of inorganic salt metabolism in dogs, conducte over a period of four years, Jones observed that convulsions frequently followed by death, occurred in the experimenta animals after a sudden alteration of the acid-base balance of th diet. The convulsions apparently resulted from an increase in the acid or alkali content of the diet beyond the limit of toler ance of the animal, as well as from a sudden reversal of the dietary reaction. Incidentally, the nutrition of the animals ha previously been excellent and no known dietary fault was dis covered other than a lack of proportion in the acid-base balanc The onset of the symptoms was sudden and characterized by marked twitching of the body, contraction of the limbs, rapi respiration, gasping for breath, and excessive salivation; bu these symptoms proved of short duration, for, with prope dietary balance, the animals recovered quickly and were subse quently anxious for food.

Apparently the experimentors were not entirely sure that thes convulsions were a characteristic reaction, for they conducte further experiments to determine whether or not a disturbanc in the acid-base balance of the diet was an etiologic factor. Cer tain observations made on blood and urine indicated a profoun disturbance in the acid-base balance of the body fluids. On a alkaline diet, the hydrogen-ion concentration of the urine wa greatly decreased, although the ratio of the ammonia nitroge to the total nitrogen was well within normal limits. When th diet was changed from a potentially alkaline to a potentiall acid one by the substitution of rice for potato, the increase i acidity was reflected in an increase in the ammonia content o the urine, while the hydrogen-ion concentration was only slightl increased. A few days before the death of the animals, and with out any change whatsoever in the diet, the ammonia content o the urine continued to drop until the ratio of the ammoni nitrogen to the total nitrogen was even higher than that ob served when the animals were on the alkaline diet. Thes observations indicated a progressive failure of the body mechan ism to maintain an acid-base equilibrium.

Loeb, in his work on selective diffusion in living organism showed that salts accelerate the rate of diffusion of dissociate alkalis and retard that of dissociated acids. It appears that th rate of diffusion of ions through membranes, which is un doubtedly influenced by the concentration as well as by th proportions of salts in the body fluids, may have a direct bearin

n such conditions as rickets, tetany, the so-called bronchial tany which frequently occurs in rachitic infants, hemophilia, rtain allergic conditions, spasmophilia, faulty kidney function, nd many other disorders the etiology of which is unknown.[17]

DISORDERED METABOLISM

Dysfunctions, diseases, malnutrition, loss or lack of growth npulse, improper diet, and environmental factors are only some the agencies which are responsible for a disordered metabolism. nimal experimentation has proven of great value in pediatrics, so far as it concerns itself with orderly nutrition. Disciples of e modern school stress the danger of the excessive use of any ne food or food element; for example, the long-continued lministration of animal proteins, especially in connection with e action of cystin on the kidneys.

In the past few years a number of experimental studies have een made of the specific relationship of an excess of certain food ndamentals to nutrition and growth. In many instances these periments have been conducted on a large scale over a period years and therefore have not been fully controlled. The gional diversifications of nutrition are many, for what con-itutes proper nutrition for one region may be most unsuitable sewhere. Among the Esquimaux the diet contains a high con-ntration of animal proteins and a relatively small amount of rbohydrates. On the other hand, in the tropics the diet is ept relatively low in animal proteins.

Opinions invariably differ as to what comprises an excess or ficiency of certain foods in a specific diet. The value of certain ets in Bright's disease and arteriosclerosis has at times been iestioned. Some observers claim to have found by experiment thologic injuries to the kidneys and blood vessels from diets gh in animal proteins, while others have discovered no such sions. Personally, we strongly favor the former viewpoint, for ere appears to be sufficient clinical evidence to show that even stin may damage both tubules of the kidneys and the blood ssels.

In all work along the lines of experimentation with either imals or human subjects, various important factors must be pt in mind. The period of observation must cover a con-lerable part of the life of the subject. The experiments men-oned above covered 54 days of a rat's life, or approximately four d one half years of a man's life. They were later extended to e year, or approximately thirty years of a man's life. The

experiments must be so exacting that the excess of the foo element must be the only difference between the controls and th experimental animals. Also, it is most essential that the diet o the control and the experimental subjects be adequate for growt and maintenance and be as closely comparable as possible, excep for the experimental variables.

It was discovered that rats which lived for one third of the lives on a diet containing 70 percent of protein were near comparable to the controls in size, but of a lower weigh Naturally there was almost a complete absence of fat. There wa an increase in the weight of the kidney and a decrease in th weight of the liver. No pathologic changes were found in th urine or in the kidneys of those rats which had lived on 70 pe cent of protein or on a diet including one percent of cystin.[19]

DYSFUNCTIONS AND METABOLISM

It is probable that the inherited cell structure is comparativel incomplete, and that unless proper selective nourishment supplied, nature's perfect plan will not be attained. When on finds organic dysfunction in very young children of good in heritance and in an ideal environment, he will probably co sider that the disturbance has been caused by certain poison derived from the splitting of the foodstuffs ingested. The chil is more apt to be affected injuriously by the intake of exce foodstuffs after reaching maturity than before.

Clinicians have long known that the lower animals possess th physiologic characteristics of the human species, and that muc scientific knowledge has been obtained from experimental studi on animals. Smith, Noise, and Jones used rats in experiment work on the relationship of diet to renal lesions; they foun that the young animals appeared to be less susceptible to th injurious effects of an excess of food, particularly of protei content, than were older animals. This same fact has bee observed in nutritional work with young children. In old animals which had been fed on a diet rich in proteins, structur changes were noted at intervals of 90 to 150 days after a un lateral nephrectomy had been performed. The lesions foun included both glomerular and tubular changes with a dilatatio and active proliferation of the lining epithelium. Similar co clusions can be arrived at in children only by a study of th symptomatology.

The experiments were begun when the animals were from 1 to 202 days old and were completed when the animals were fro

1 to 348 days old. The kidneys of the animals on which a phrectomy was performed at the age of 30 days showed no anges analogous to the renal lesions observed in the rats erated on after maturity. In the young rats maintained on a ndard diet for periods ranging from 177 to 380 days no signifint renal lesions were noted after a right nephrectomy. The act diet used was not included in the description of the periment.[20]

METABOLIC FOOD ESSENTIALS: PROTEINS

Metabolism is worthy of its name only when the biologic cell fed with food elements suitable to its functional activities. hen we place the proteins in the front rank of cell food contuents, it is not because we wish to belittle the other food ements, but because these proteins constitute some nineteen rcent of the human body. They are universally considered so to be the most important nutrients of the body, in that they rm the great elementary mass of all actively functioning organs. omparatively speaking, the fats and carbohydrates are more posits of food stuffs.

Remarkable as it may seem, more than adequate nutrition in ildhood adds comparatively little to the protein which forms e permanent part of the body. After the ingestion of a large nount of all foodstuffs, an extra quantity of protein is held mporarily in the cells of the body, and upon the cessation of e high-protein diet is gradually eliminated. Lusk has termed is "deposit protein." The protein molecules are extremely mplex, being formed by a large number of amino-acids. For ample, 100 grams of lean beef represent about three grams of trogen. When taken into the stomach proteins are quickly tacked by the hydrochloric acid and pepsin and broken down to proteoses, peptones, and polypeptids. In the intestine the ypsin and erepsin carry these through the dipeptid stage and rm the amino-acids which are absorbed into the blood stream, which they are transported to the cells of the body. Here ey serve to replace the "wear and tear" of tissue waste, being synthesized into body protein. The excess of amino-acids ually present is oxidized to furnish energy, just as in the case fat and carbohydrate. As the amino-acids circulate in the ood they cause a stimulation of the oxidative process in the dy cells, sometimes referred to as "specific dynamic action."

When protein is metabolized the sulphur which it contains is omptly eliminated, and after a short interval the nitrogen also

is eliminated, provided the kidneys are not diseased. Und ordinary circumstances in health the excretion of nitrogen c responds fairly closely to the nitrogen ingestion, and the in vidual remains in what is called "nitrogen balance." Such equilibrium may be established at a high level if he is accustom to consume large amounts of meats and other protein-containi foods. With the dietary habits of the present generation m persons maintain a balance with an intake of 12 to 19 grams nitrogen a day, or about 75 to 118 grams of protein. Howev equilibrium can be established and maintained for long perio at as low a level as three to seven grams daily, provided the d contains sufficient total calories to cover the daily expenditu It is important to have a sufficient proportion of these calories the form of carbohydrates. The protein itself must be of composition which corresponds fairly closely to human mus protein in its amino-acid content. The proteins of meat, eg and milk are suitable. Gelatine or the incomplete proteins maize cannot replace the wastage of body tissues.

Although it has been clearly demonstrated that the individu can live on an intake of three to seven grams of nitrogen dai experience has shown that, for most persons, life on such a diet singularly unattractive. In disease there may be distinct chang in protein metabolism. Infectious diseases with toxemia, canc and other wasting illnesses are accompanied by a "toxic destru tion of protein." In children, with their energetic mental a physical activities, the nitrogen excretion is higher than t intake.

In certain diseases it has been found that patients who a given ten grams of nitrogen in their diet will excrete as much twenty-five grams, and if there is a forced intake of twenty-fi grams, the excretion will climb five or ten grams higher. In t so-called toxic diseases, Shaffer, Coleman, and Kocher could n reduce the nitrogen excretion below seven to fifteen grams a d even on an ample diet containing two to four grams of nitroge

The idea held by many that protein food is consumed on during active muscular exercise is erroneous. Incidentally t eating of large amounts of indigestible protein, such as ov cooked meat or coarse vegetables, will be accompanied by t excretion of a considerable proportion of unabsorbed food in t feces. Also, in certain diseases with intestinal disturbances t nitrogen in the feces may rise to abnormal levels. However, un normal conditions the protein is all absorbed and the sto contain daily about one gram of nitrogen derived from t intestinal tract.[7]

TERMINING THE BIOLOGICAL VALUE OF PROTEIN

The pediatrician often asks himself, and is also questioned by
ers, as to the possibility of estimating accurately the amount
protein, animal or vegetable, which a child utilizes in metabo-
m. Clinically speaking, the many gradations of inherited
function, the obscure environmental factors, both mental and
sical, the variations of growth and growth impulse, and the
ividual whims and indulgences of the child which lead it to
ose foods quite at variance with actual necessities, are but a
of the points concerned with protein utilization. Moreover,
clinician finds his tests too rigid for the elastic ambulations of
child's life.

Restrictive laboratory tests might embody the following factors:
(1) A diet containing as far as possible only that protein or
xture of proteins which are to be investigated. (2) The
sence of no non-protein nitrogenous substances in the diet
ept those present in the food under investigation. (3) A food
ake so adjusted in its composition and amount that dietary
tein will not be used as a source of energy except as con-
ioned by the incomplete utilization for the maintenance of the
rogenous integrity of the tissues, for their growth, or for the
boration of milk proteins. Even if it were possible to meet
se test conditions, the interpretation of the results would be
no means simple. It would be complicated by the fact that
h urinary and fecal excretions contained nitrogen resulting
m tissue catabolism or from unavoidable tissue wastage, as
l as from the nitrogen which was a direct consequence of an
omplete digestibility or a result of the subsequent incomplete
lization of the dietary protein.

n the nutrition of children, one must never forget that the
protein value of a food is not necessarily constant, any more
n is its content of digestible protein. Indeed, many factors
dify the digestibility of the protein of a food and influence the
logic value of its digestible fraction and of the net protein
tent which is subject to the influence of such factors.[21] Thus,
haps unconsciously, one enters the field of the biologic value
proteins at different levels of intake. It is probably not recog-
ed also that the biological value of a protein varies with the
to which it is put in the body; an important step in our
rition problem, for this means the maintenance of the nitro-
ous integrity of the tissues, the synthesis of new tissue in
wth, and the synthesis of milk proteins in lactation, which
y be expected to require different proportions of amino-acids.

Thus the nitrogen of a given protein may be expected to be mor completely utilized in serving some one of these functions tha in serving another. These differences in biologic value are cor cerned with the amino-acid make-up of the protein, as compare with the several distinct requirements for amino-acids.

It is generally believed that the chemical constitution of protein determines entirely its biologic value. This belief tacitl assumes that the economy with which the cells utilize the amin acids supplied to them is unaffected by the abundance of th supply, particularly by the rate at which the amino-acids ar transported to the cells from the intestinal tract. It also assum that the undigested fraction of a dietary protein is representati in its amino-acid make-up of the protein as consumed, so th factors influencing the digestibility of the protein would hav no effect on the proportions of the different amino-acids absorbe into the blood. It must assume, also, that no great differenc occur in the rate at which different amino-acids are liberated fro protein during digestion, or that, if such differences do occur, th storage capacity of the tissues for absorbed amino-acids is suf ciently great to insure the presence there, throughout the digesti period, of optimum proportions of the several amino-acids f synthetic purposes. It also assumes that until the demands of th body for protein are covered by the protein intake, amino-aci are not oxidized in the body except in so far as they are unavai able for synthetic purposes; and hence factors affecting th intensity of the oxidation processes can have no effect on th utilization of amino-acids for structural purposes. These assum tions are either extremely improbable or highly debatable.

Anyone who is unwilling to heed modern scientific facts shou not assume the responsibility of feeding children. Nature scheme of balance is a combination or a blending of foo essentials, a fact amply attested scientifically. For example, th mixed proteins of milk give the highest biologic values. Me proteins separated from the extractives are quite as complete utilized as the proteins of milk. If the extractives are not r moved, however, the average biologic value of the total nitroge of meat is distinctly less than that of milk. It has been show also, that the main protein of milk is distinctly less efficient i nutrition than the mixed proteins of milk. The average biolog value for casein obtained in a series of experiments was 70.8. a five percent level of intake, casein, in fact, seems to be n higher in biologic value than the proteins of corn, for which a average value of 72.0 was obtained.

The biologic values of the mixed proteins of three cereals amined, corn, oats, and whole rice, showed rather distinct lerences; the average values being 72.0 for corn, 78.6 for oats, d 86.1 for rice at a five percent level. The average biologic lue for potatoes was found to be low. As might be expected, e increase in the level of protein feeding has lowered the ologic value of the protein. In the case of the mixed proteins of lk, on the other hand, this decrease is not great.

In a report on the growth-promoting value of lactalbumin and casein, Osborne, Mendel, and Ferry have shown that when s were fed rations in which the amount of these proteins was e only factor limiting growth, the gains in weight per gram of otein consumed increased to a maximum and then decreased pidly as the protein concentration of the ration increased ntinuously. Cereal proteins followed along the same lines, ture's method of handling excess. The first possible explana- n is that the greater the rate of influx of amino-acids to the sues from the digestive tract, the less the economy with which ey are handled. Another factor that may plausibly operate in lucing the biologic value of a given protein or protein mixture its concentration in the ration increases, is an inevitable stage of amino-acids in the oxidative processes of the cells. this wastage of amino-acids by oxidation increases more rapidly an the protein intake, a greater percentage loss of absorbed trogen, due to inevitable oxidation, will result with rations ntaining higher percentages of protein.

The biologic value of a protein is fixed by its chemical consti- tion, yet this biologic value may be upset by many physiologic ctors. This brings to mind the fact that certain restricted food ets do not always achieve the results expected.[22] The increase the metabolic rate is greater from protein food, with reserva- n, than with any other. A more rapid cell respiration always notes a greater oxidation process within the cells, and the ort of the child's body to rid itself of a heat excess through ysical regulations.

At high temperature even a small quantity of protein causes a nsiderable rise in metabolism. A thought concerning the trition of premature and very young infants is embodied in s fact. We have assumed in our clinical work on nutrition that lower protein level ingestion, if balanced by a high level of ner food constituents, has proven of more benefit than the gher protein level employed in former years. Indeed, Chitten- n, in a number of experiments on himself, determined that

diets containing 40.0 to 36.6 grams of protein were sufficient f nutrition, rather than the 118 grams for many years consider the total amount absolutely necessary to health. This auth believes, and we agree whole-heartedly with him, that the ord nary large quantity of protein consumed, and we assume l means animal protein, is due to lack of self control in eatin It has long seemed to us that the laity have placed an ove valuation on the need of protein in the diet in amounts mo conducive to the general health and well being of individua Even in children the excessive eating of meats and eggs impos a needless strain on the liver, kidneys, and other organs co cerned in the transportation and elimination of the end-produc of protein metabolism. The peasantry of Europe, strong an sturdy, employed even as fairly young children to carry lar burdens, rarely eat meat except on fete days and other ra occasions.

This calls to mind the fruitarian whose exclusive diet consis of fruits and nuts, and also the members of the Brahmin an Hindu castes, who are strict vegetarians. The rare exception these diets is an occasional drink of milk, which does not co stitute a complete diet since the iron content is small and th water content excessive in proportion to the food principle Complete milk diets either in health or illness have but litt biologic value and are not adequate.

In connection with the digestion and metabolism of protein some of the many dangerous conditions with which the clinici frequently comes in contact can not be over-emphasized. Th digestive tract cannot utilize an excess of animal proteins. Ther fore when this food is present in too great quantities, putr faction takes place and the intestines elaborate vicious poison among which may be listed indol, skatol, putreosin, cadaveri and others which eventually cause pathologic changes with certain organs and tissues. We feel justified in saying that th greatest number of somatic illnesses originate from this ma assimilation of animal proteins.

But other things being equal, it is highly probable that th younger the child, the more protein it can assimilate an metabolize. In the growing period of organic youth the orga require a higher proportion of protein than is necessary aft maturity has been achieved. As the years advance, health an longevity are best served by an increasingly small intake animal protein. In fact, excess quantities of any food essenti tend to disturb the delicate adjustment of the body mechanis and bring any dysfunction, minor or major, into prominence.[20]

FFECTS OF TEMPERATURE CHANGES ON PROTEIN INTAKE

Body requirements for the animal proteins decrease in pro-ortion to a heightened temperature. Therefore, during the hot, umid months the young child would require less of this type of ation than would be required during the winter. It has been oted, too, that at this period the appetite craves less protein. enis and Borgstrom, in their investigation of the level of protein ntake, as indicated by the total nitrogen excretion in the urine uring the warm and cold months in New Orleans and in lassachusetts, state that increase in temperature is accompanied y a decrease in protein intake, and that apart from the variations ue to seasonal changes, the inhabitants of the semi-tropical ortions of this country probably consume an amount of protein onsiderably below the quantity reported as the average intake or the nation.

However, the conclusions of these authors were that seasonal ariations in temperature in temperate zones are not great enough o influence the level of protein metabolism in man, for it is the ame in winter as in summer. The difference in protein metabo-sm between those living in New England, in western New York, nd in the southern states is small.[23]

AMINO-ACID SYNTHESIS

The amino-acids are essential for the proper functioning of ody cells. They are carried to the cells by the blood stream and ne lymphatic system after their absorption from the alimentary anal. Then too they are stored in the cell protoplasm as pro-eins and are constantly catabolized. One can readily sense the emands of the many specific cells which require selective amino-cids for their normal activities, and which lure them from the lood stream, much as the good housewife selects from the eddler's cart those necessities suitable for her household.

The process of catabolysis varies widely in its intensity. The nino-acids may be completely broken down to water, carbon ioxide, and ammonia, resulting, apparently, only in the supply-g of energy. Also, a partial degradation may result in a con-ersion of the fragments of the amino-acids into products having vital function in the various processes of the body. Thus the rosin liberated in the cells presumably gives rise to adrenalin nd to trytophan, which is believed so necessary for the forma-

tion of thyroxin, the active principle of the thyroid gland, and of cystin, which is probably essential for the synthesis of glutathione, which is of vital importance in the oxidative processes of the organism. If amino-acids are not directly furnished to the cells they must be synthesized from other metabolites, a termination not wholly desirable.

Should these metabolites not be present, however, there arises a malnutrition, growth ceases, reproduction is interfered with and death may follow.

Osborne and Mendel have shown that when gliadin, the alcohol-soluble protein of wheat gluten, was the only source of protein in the diet of young rats, growth was inhibited. The animals did, however, maintain their body weight at fairly constant levels. Can there be a similar analogy in certain forms of malnutrition which occur in children? [24]

CARBOHYDRATES

Carbohydrates are not only the simplest of all foods but the most important from the standpoint of the total energy furnished to the body. Chief among these foodstuffs is starch ($C_6 H_{10} O_{5\,x}$). The saliva and pancreatic juice convert starch into soluble starch, then into dextrins, then maltose, and then glucose. As such, it is absorbed through the intestinal wall into the blood and, after passing through a number of intermediate stages, is oxidized in the cells, forming carbon dioxide and water. In its oxidation it gives off all the potential heat which, like any other fuel, it contains. Carbohydrates are rapidly digested and absorbed, and their energy value and the rapidity and ease with which they are utilized by the organism are considered in treating serious cases of malnutrition.

At the ordinary level of blood sugar the glucose leaves the circulation as it is oxidized or utilized for the formation of fat. Rising a little above this level, it may be stored in the liver in the form of glycogen. Mounting still higher, these three sources of loss may continue and may even be augmented, when finally the blood sugar may rise above the renal threshold, and glycosuria will result. Stanley R. Benedict has observed a normal excretion of carbohydrate amounting to about a gram a day.

The normal renal threshold varies in different individuals but as a rule there is no spilling of sugar unless the blood glucose rises over 0.15 to 0.16 after a heavy meal of sugar.[7]

FATS

Fats seem to be comparatively inert substances, with long and omplicated chemical formulae. Not much certainty exists egarding the mechanism of their digestion, absorption, and netabolism. Be that as it may, they are extremely important, ince they furnish about a third of our calories in health and a nuch larger proportion in starvation and diabetes.

Simple lipoids, or fats, are esters of the triatomic alcohol lycerol. Edible fats, such as are given to children, are usually nixtures of tristearin, tripalmitin, and triolein, substances which iffer considerably in their melting points but not very greatly n their chemical formulae. When taken into the stomach they ncounter a lipase which may become a factor in digestion if ne acidity is low and the emulsification sufficient to permit of ood surface action. The presence of much fat in the stomach—nd this should not be forgotten in treating sick children—nhibits the secretion of acid and slows the passage of food into ne intestine. This knowledge has been used by the writer in ases of hyperacidity in children when the stomach contractions re increased and food is not properly predigested.

Small amounts of fat or emulsions such as milk or oils may eave the stomach rather rapidly. Usually the fat passes the ylorus a little at a time and enters the intestine, where it finds deal conditions for its digestion. The pancreatic secretion ontains large amounts of active lipase which is rendered even nore active by the presence of bile.

The intestinal wall also secretes a lipase. The pancreatic uice, bile, and intestinal secretions are alkaline, so the fatty cids formed by the hydrolysis of the fats unite with the alkalis o form soaps, which in turn aid in the emulsion of the rest of ne fat. The solubility of these fatty acids and soaps is increased y the bile, which, indeed, seems to accelerate every stage of the rocess. It is probable that the fats are absorbed from the ntestine in water-soluble form as fatty acids and soaps and are nen resynthesized in the wall of the gut. This fat passes into ne blood stream by way of the thoracic duct, through perhaps ome may find its way through other channels.

As a rule the fat is withdrawn from the blood and metabolized stored in the tissues almost as rapidly as it is absorbed. The ganism is usually able to deposit a fat which is characteristic of e species, but if the food contains large amounts of foreign ts these may find their way unchanged to the deposits of the

body. As a rule, fats with low melting points are favored, for they are better assimilated than those which do not melt at body temperature. Even such fats as butter and bacon, which are easily absorbed in moderate quantity, cannot be well taken care of in amounts of over 300 grams a day.

Fats are rich in hydrogen, which furnishes a great deal of heat for a small weight, therefore they have a great fuel value. They consume a correspondingly large amount of oxygen, binding much of it with hydrogen to form water. Rubner, in his studies, allowed for about an eight percent loss of original energy content in the stools with a diet in which vegetables predominated. Atwater allowed a five percent loss of animal fat and a ten percent loss of vegetable fat in the excreta.

In an emergency, fats can be formed from carbohydrates. There is little evidence at the present time regarding the formation of fat from protein in the human body. Theoretically this may take place, since about one-half of the protein molecule is converted into glucose in its normal combustion. Atkinson, Rapport, and Lusk have demonstrated by experiment on dogs that, after the ingestion of meat in very large quantities, there is a conversion of protein into fat as the dominant feature of the process. From a chemical standpoint it is easy to conceive of the conversion of the glycerol radical of fat into carbohydrate in the animal body, and this probably takes place in the human organism, and therefore in the child.[7]

THE MINERAL SALTS

In our rambles through the vast empire of metabolism, we often stop and wonder if the proteins and other elements have not been unduly favored over the inorganic salts. On every side the word "protein" is heard, but if one comments on the activities of the mineral salts, one's hearers are apt to become apathetic. From experimental embryology we learn "that certain mineral agents, in the case of some at least of the lower forms of animal life, dominate and determine the development and physiological state of definite organs and structure." If in the lower forms, why not in the higher?

There are two general groups of mineral salts. The first group includes:—sodium, potassium, calcium, magnesium, chlorine, iodine, phosphorus, sulphur, iron, manganese, copper, zinc, and perhaps cobalt. Salts whose importance is open to question form the second group found in the body, including:—aluminum, antimony, arsenic, barium, bismuth, boron, bromine, cesium

omium, fluorine, germanium, gold, lead, lithium, mercury, kel, rubidium, selenium, silicon, silver, strontium, tin, titam. and vanadium. Only three of this list of elements, boron, mine, and vanadium, are important in animal physiology.[25]

Without question, the salts are of extreme importance to anic life. As an illustration, sea water is admirably suited for poses of observation, for "its constituents can be ascertained l its ingredients altered at will." We know for instance, that hough the amount of potassium in sea water is extremely ll, yet so powerful is the influence of this metal upon develop-nt and growth, that the absence of that ion alone is fatal to echinoes."

To almost all forms of animal life, the salts of lime are of the atest necessity. If sea water, which holds in solution carbonate lime, sulphate of lime, and the two tribasic phosphates, is rived simply and solely of its carbonate, then the blastulae of echinoes so circumstanced present a crumpled and opaque earance, while should the skeleton have been formed before larvae were subjected to such impoverished sea water, the eton then is dissolved. Or again, if one of the tribasic sphates be the only lime salt present, then the eggs exposed uch untoward conditions die during segmentation; but if the water employed in the experiment be deprived of all four of ime salts, then the cells of the oosperm, as they segment, lose rely their cohesive properties and separate from each other hwith. From these findings of the action of the inorganic s on the lower forms of animal life, one can find analogies in workings of these substances in the higher animal forms, such ng the human organism.

Under natural physiological and biological conditions, breast k is a complete and perfect food for the infant, for it contains only proteins, fats, and carbohydrates, but also potassium, um, lime magnesium, and iron, as well as phosphoric acid chlorine. Iron, which is so lacking in artificial milk modifi-ons, is certainly a most necessary element, and its absence ndoubtedly connected with many of the cases of nutritional nia. It can readily be assumed that for the maintenance of body of the older child, as well as for the development, th. and secure establishment of the resistance powers of the during early childhood, a persistent and adequate supply of e inorganic substances which belong to milk is as imperative continuous and efficient supply of the other food elements. nce sea water contains so many inorganic salts necessary to bolism and since the denizens of the deep derive, directly

or indirectly, their nutrition from sea water vegetation, it stan to reason that marine animals are a most satisfactory source supply of these salts. Not only does marine vegetation contai the salts already mentioned, but a rich iodine content is al present. Every clinician is familiar with the appearance of child whose diet is grossly deficient in minerals. In an emergen these minerals may be given in the form of medicine. Howeve when the question is one concerning general growth and develo ment, the salts had best be supplied in the form of the frui vegetables, fish, and other foods which contain them.

An adequate supply of easily utilizable phosphorus is essential to human life as are wholesome air and good water f cell multiplication, and the processes of metabolism generally a dominated and regulated by a complex phosphorus-containi acid known as nucleinic acid. If the phosphorus content of livi cells be defective, then the process by which the wear and tear cell substance is made good is faulty, and obscure ill heal results. Although the nature and cause of rickets and alli conditions are, to a certain extent, unknown, it cannot be deni that metabolizable phosphorus and lime salts have a distin bearing on the cure.

One could continue indefinitely to show the importance the salts to proper nutrition. The growth and function biologic cells require all salts, but especially phosphorus. Th latter, too, is very necessary to the expectant and nursing moth All the salts that she requires should be in an easily assimilat form. Also, good pasturage is a primary requisite in assuri the salt content that will be essential for the infant fed on co milk.

In connection with the changes which naturally occur duri puberty, the salts are invaluable as an aid in motivating meta lism. Both phosphorus and calcium are much needed by t developing organism. It is altogether probable, too, that calciu through its cohesive property, tends to keep the cells of t organism together. As is well known, the coagulable powers blood and milk are largely dependent upon the presence calcium, and the properties of proteins are seriously dama when the latter are deprived of their calcium content.

In older children an adequate supply of metabolizable calci is necessary, for the irritability and sensitivity of the phagoc and nerve cells and the contractile powers of the muscles dep greatly upon the amount of available calcium and the qua tative relationship of this metal to the others; that is, to po sium, sodium, and magnesium. All these metals play an

ortant role in maintaining the rhythmic contractions of the art and the functional activity of every muscular organ and ructure in the body.

It must be admitted, of course, that our knowledge of the rect and active part which mineral substances play in vital d nutritive phenomena in the human organism is still very eagre, but the fact that they do play a part is very evident. inerals help to maintain a normal composition and osmotic essure in the liquids and tissues of the individual, a function hich is of the greatest service. Furthermore, by neutralizing ids they tend to preserve the alkalinity of the blood, and some of e compounds formed thereby have a beneficial diuretic action.

Many individuals note with considerable concern that the neral content of many of our foodstuffs is tampered with, for ere seems to an ever-increasing tendency on the part of manu-cturers to deprive foods of their natural constituents. The eal foods present a case in point. Also, on account of the roduction, nearly a quarter of a century ago, of the roller ocess of milling wheat, and of the growing demand for white ur, a very large percentage of the mineral constituents of eat are now eliminated from marketable flour, and within ent years its wholesomeness has been lowered by injudicious posure to the influence of some bleaching reagent like nitrogen roxide.[26]

Up to within comparatively recent times, the occurrence of nute amounts of certain mineral elements in plant or animal sues has commonly been supposed to be the result of acci-ntal contamination. At the present time, however, there is a owing feeling that these elements may not be accidental in ure, but are actually necessary for life. The relatively large ounts of zinc constantly present in all living tissue points to required and definite utilization. The work of Bertrand, illies, and Delezenne has done much to emphasize the im-tance of this metal in the functional activity of living cells.

There are certain metals which, although widely distributed, seldom found in either plant or animal tissues, while others found in relative abundance; that is, in comparison with the ounts of these metals to be found in soil or water. A familiar mple is the iodine in sea weed. It is a curious fact that nature elf has roughly separated toxic from non-toxic mineral sub-ces. In natural foodstuffs there are found iron, zinc, and nganese in about equal amounts; but toxic elements such as , arsenic and mercury are also found, fortunately only in ute quantities.

Zinc is a decisive factor in the salt metabolism of children The wide distribution of zinc in foodstuffs, and particularly it concentration in germ cells, in the endosperm of wheat, and in the yolk of eggs, indicates that it is an inorganic substance which is most essential to nutrition during the early periods of growth Also, its constant presence in definite amounts in the blood and tissues of adult animals points conclusively to its utilization It has been estimated that a man consumes from ten to fiftee milligrams of zinc daily. In children these amounts can onl be approximated, since their appetites and food desires are s irrational. Man's urine excretion contains an average of on milligram per day and does not fluctuate within wide limi while his fecal excretion varies according to the amount of zir ingested. The tissues are literally bathed in a zinc medium, an in addition a large amount is stored in them.

Some foods are actually floating mines of inorganic salt notable among these being oysters, lobsters, and crabs, which co tain iron, manganese, and zinc. It is known that the tail meat lobsters contains appreciable amounts of copper and zinc. It entirely probable that some children in apparent good healt who have nevertheless been fed on a diet consisting largely highly milled cereal foodstuffs have counteracted these deficie products by the consumption of marine food.

When corn, wheat, rye, and oats are highly milled, the r sulting degermed substances, such as corn meal, white flour, ar the many patented food products, are deprived of the great part of their salts of copper, iron, manganese, and zinc. T highly polished rice is another example. Similar processing affe other essential salts. Naturally the cells of the child suffer fro these losses.[27]

Another important member of this same group, but one th is very often sadly neglected in the scientific nutrition of ch dren, is fluorine. McCollum, Simmonds, Becker, Banting, well as many German writers, notably Kronfeld, have extoll its importance. Investigators have found fluorine in considera quantities in sound teeth. This would seem to indicate th fluorine is one of the structural fundamentals in enamel a perhaps in dentine. It is also found in the heart, kidneys, bra lungs, spleen, and liver. It seems to have a tendency to accun late in the body tissues. This mineral is found in a number foods, such as egg yolk, calf brains, and milk. However, it reac its highest content in the leaves of plants, the skins of ap and bananas, in mineral sea water, and in lobster shells.[28]

MINERAL METABOLISM IN INFANCY

The metabolism of the inorganic salts in infancy is a study of general concern. When one realizes the insecurity of life in the early weeks of the artificially fed infant, its disposition to anemia, rickets, and allied intestinal conditions, and to many forms of organic dysfunction, the importance of a well proportioned mineral metabolism becomes increasingly evident. In plainer language, infants should be fed on a diet which contains, among its other constituents, all the commonly understood mineral salts.

It may be logically assumed that the metabolic requirements for any given child and the relationship of quantitative amounts of all the nutrients necessary to proper metabolism may be wholly individual. In brief, it is impossible to devise a milk modification which will be adaptable for any group of infants. In cases of suspected mineral deficiencies, the simplest and at the same time the most accurate methods are determined by the ash value of foods and by an analysis of the urine and feces. Though such cases may be diagnosed readily, they are often difficult to treat.

It is impossible, as has been said, to measure the mineral metabolism or to know what amounts of the mineral elements the average child needs in growth, repair, development, and metabolism, without clinical experimentation. In fact, Albee and Neuberg have pointed out that the ash does not represent the food fundamentals, since much of the chloride, sulphur, and sodium contained in the food product may be lost in the "ashing" process, and this resulting ash contains the mixtures of oxides and carbonates, which are impossible to calculate. The phosphates, too, may be converted into pyro- and meta- phosphates and changed into unknown properties. The conditions governing the formation of the oxides, carbonates, and phosphates differ conclusively and the results of ash analysis should be taken guardedly.[29]

LACTATE METABOLISM IN INFANTS

Of late, lactate metabolism has aroused much interest among clinicians, and the effects of lactic acid on the absorption of inorganic salts, as studied by Klotz, is a matter of importance. It is possible that the effects of the lactate of milk are due directly to the lactate ion. There is apparently no marked difference between the lactate of the blood in infants following the

feeding of lactic acid milks and that of the controls following ordinary feedings. This warrants the conclusion that the lactic ion does not in any way directly influence the peripheral metabolism. It has been suggested that the lactate ion may act on the complex metabolism of the liver.[30]

CALCIUM AND PHOSPHORUS METABOLISM IN CHILDHOOD

In the study of nutritional diseases in children, and from clinical impressions, one arrives at the conclusion that calcium and phosphorus are two of the most essential salts in the proper balancing of metabolism. In an exhaustive series of experiments Sherman and Hawley have determined the complete balance of intake and output of calcium, and, in most cases, of phosphorus.

Their findings were determined in four progressive series of experiments, including in all 21 children between the ages of 3 and 14 years, and covering a total of 417 experimental days, in 139 experiments of 3 days each. On an ordinary mixed diet containing 750 grams of milk daily and furnishing a total of 0.74 to 1.02 grams of calcium per day, children 3 to 13 years of age stored 0.15 to 0.62 grams of calcium per day, the amount being approximately proportional to the size of the child, and averaging 0.01 grams of calcium per kilogram of body weight per day.

When the daily allowance of milk was increased to 1,000 grams the storage of calcium was increased. The results obtained indicated that the optimum storage of calcium is made when the diet contains one quart of milk per day for each child. This, with a normal allowance of other foods, will usually mean a daily intake of at least one gram of calcium for the growing child.

Children do not seem to utilize the calcium of vegetables as efficiently as they do that of milk. In general, the conditions influencing the storage of calcium tend to influence that of phosphorus in the same direction. Since the child of 3 to 13 years, although eating less food than the adult, will need more than 0.68 grams of calcium in his food to support optimum calcium storage and bone and tooth development, it would seem that a higher dietary standard for calcium, perhaps one gram or more per day, would be better in all cases.[31]

The minerals found in the average well balanced dietary of the child are phosphorus, chlorine, sulphur, calcium, magnesium,

potassium, sodium, iron, and fluorine. These salts are found collectively and individually in a wide range of foodstuffs, and each salt has a specific nutritive value in metabolism. It is the responsibility of the pediatrician to impress upon the parents the value of the foods in which these elements are found.[28]

Elsewhere it has been pointed out that the mineral salts are of vital importance in the activities of the cell and that they particularly influence the growth and repair processes of the bones and teeth. In spite of the undeniable value of calcium and phosphorus in early childhood, these two salts should not be unduly emphasized. The necessity of calcium in the child's diet is balanced by the power of the organism to absorb it. Calcium chloride and calcium lactate are quite easily absorbed, the latter being about ten percent soluble as compared with the carbonates, phosphates, and most of the other inorganic salts; that is, with calcium content. The solubility of organic calcium is favored by the acidity of the intestines, and therefore reverts back to an acid condition of the stomach contents. Indeed, the ingestion of lactose, as Inouye remarks, favors the maintenance of a high blood calcium concentration in parathyroid disturbances and tends to render the intestines acid. The diffusible calcium salts of the child's food are increased by this acidification, as well as by tryptic digestion.

A knowledge of the function of calcium as it concerns growth, repair, and development of the bones and teeth, and a realization of the importance of recognizing the normal mean calcium content of the body at different stages of its life history in the work of salt metabolism, will aid in prescribing the amounts of calcium necessary in any given diet.[32]

Indeed the more one studies the health and welfare of children the more he is inclined to believe that nature seeks the right balances of food fundamentals in her cells, and that a disharmonizing excess throws her off balance. An illustration is seen in the effect of variations in the proportions of calcium, magnesium, and phosphorus in the diet. The importance, for instance, of physiologically balanced salt solutions in the physiology of a large variety of plants, lower animal organisms, and excised tissues are, we believe, well established. It is of considerable importance to determine whether variations in the intake of mineral salts are capable of disturbing the physiological balance among the mineral ions in the child's tissues to such an extent as to affect the normal functioning of its body.

Certain experimental findings by Hoag and Palmer seem to

leave no doubt that a more or less balanced condition of calcium, magnesium, and phosphorus in the child's diet are essential to normal growth and function. These authors found that the growth and mineral balance data pointed definitely, in their opinion, to a magnesium excess as a disturbing factor in nutrition. There must, indeed, be many important vitamin-mineral relationships in nutrition of which we know almost nothing.[32]

INORGANIC SALT ABSORPTION IN THE INTESTINES

Bergeim arouses interest in his discussion of the absorption of inorganic salts, particularly those of calcium, phosphorus, and iron, in the small and large intestines. He shows that a condition of experimental rickets can be produced either by low calcium plus high phosphorus, or low phosphorus plus high calcium diets, this condition involving a loss of calcium or phosphorus, or both, to the body by way of the intestinal tract. Especially noteworthy is the fact that minute amounts of antirachitic substances, such as may be found in a few milligrams of cod liver oil, may swing the balance of these elements from strongly negative to strongly positive.

At the present time, controversy continues as to whether the defect in rickets lies in the inability of the bone cells to utilize calcium and phosphorus brought to them, or in a failure of absorption of these elements from the intestines. Experiments on albino rats showed a great absorption from the small intestine. The groups studied showed a considerable secretion of phosphate into the upper intestinal tract. The animals given cod liver oil gave a positive calcium balance throughout the intestines. Phosphorus secreted into the upper tract was absorbed in the lower intestines to produce an ultimate positive balance of this element. In rachitic animals the calcium absorbed in the upper intestine was excreted into the lower intestine, leading to a negative or subnormal balance. At the same time there was a failure of adequate reabsorption of phosphate, and hence a loss of the latter to the body. The failure of calcification of absorbed calcium is believed to be due to the low phosphate concentration of the blood.

Anti-rachitic substances may act by elevating blood phosphate through promoting the breakdown of organic tissue phosphates, thus leading to increased deposition of calcium with lessened excretion into the gut and consequent better absorption of phosphate therefrom.[33]

MINERAL SALT EXCRETION

In infant nutrition the knowledge of the relationship between the amount of food ingested and the amount excreted, measured in nutrients, is of inestimable value, particularly in obscure cases of malnutrition. This is of especial importance in mineral salt metabolism, for, as has been said, these salts motivate nutrition and are partly responsible for health, growth, development, and the repair of organs and tissues of the child.

Calcium is deficiently low in many diets of infants and children, and it is the one mineral which apparently acts as a whip salt to all of the others. Children's nutritional needs undoubtedly require the retention of larger amounts of calcium to meet greater demands of growth. It would seem that the actual amount of calcium necessary for infants, as determined by metabolism experiments, remains to be better established and that scientific accuracy cannot be depended upon even to establish the measurement of their nutritional need.

Magnesium is largely excreted in the feces, possibly some 70 or 75 percent being eliminated in normal periods, while the urine is unaffected. Magnesium retention is diminished by acids and increased by the alkalis.

The excretion of sodium is by way of the urine and in amounts of from 79 to 92 percent in normal infants. Acid alone increases its secretion but both acids and alkalis affect its retention in the body.

In a series of experiments with potassium, while the intake seemed a large one, it was apparently not abnormally high for the infant under observation. There is a dissimilar discrepancy among children as to the quantities of any salt which they can readily metabolize. Neither acids nor alkalis were found to alter the secretion. The amounts eliminated in the urine were from 88 to 88.5 percent. Sodium drives out potassium, for the retention of potassium is the result of the tendency of the alkali to cause potassium retention and is less than the force which sodium exerts in causing the excretion of potassium. The child's body probably retains 71 to 63 cc. of 0.1 n potassium in normal periods, which represents 24 to 31 percent of the intake.

The child's demands for a potassium and phosphorus intake are urgent, particularly for the latter, to meet the requirements of growing bone. Raw milk is rich in it. Its retention also is largely diminished by acids and alkalis. Some phosphorus is stored as neutral phosphorus and is seen in the phosphatides, nucleo-proteins, phospho-proteins, and the like.

Sulphur also is almost wholly excreted by the urine, probably in amounts of 90 percent, and acids and alkalis increase its excretion slightly, for in the feces one finds but a small amount. Chlorine is excreted almost wholly in the urine, with a percentage of 97 to 98.[29]

As hydrochloric acid is practically all excreted in the urine, it is only under most unusual conditions that it is eliminated from the bowels. One finds that the alkalis cause a marked excretion of sodium chloride in the urine. Generally speaking, the effects of acids and alkalis on mineral metabolism show many interdependencies, each element presenting a problem in itself.

Hydrochloric acid increases the excretion in the urine of ash, nitrogen, calcium, sodium, phosphorus, and chlorine. Potassium, magnesium, and sulphur are not affected. In the feces, hydrochloric acid increases the excretion of ash, nitrogen, calcium, magnesium, and chlorine; while, in this case, sodium and potassium are not affected. The excretion of phosphorus is decreased. Sodium chloride tends to decrease the retention of ash, nitrogen, calcium, magnesium, sodium, potassium, phosphorus, sulphur, and chlorine. In our problems of nutrition, as to the retention and excretion of these salts, it has not been found practical to draw an absolute conclusion from these findings in treating specific forms of somatic disease.[29]

CALCIUM REQUIREMENT OF MAINTENANCE BEYOND PUBERTY

It seems well to consider the calcium requirements from the standpoint of the older child. The demonstration by Osborne and Mendel that calcium necessarily occupies a prominent place in the inorganic food supply, and that of McCollum, Simmonds, and Parsons, that calcium is one of the limiting factors in a very large proportion of our staple foods, lends added interest to the measurement of the calcium requirement in individuals and the comparison of the amount of calcium required for normal human nutrition with the amounts found in the ordinary freely chosen food of representative groups of people.

The proper metabolism of the child nearing maturity calls for a very liberal calcium intake. The amount is usually much below the normal requirement. From various factors involved, the conclusion has been drawn that a food supply, in order to furnish essential nutrients in relative proportions corresponding to the needs of the body, should contain at least 1.0 gram of

alcium or (1.4 gm. of CaO) for every 100 grams of protein. Ve know that unfortunately this is very rarely the case. When he results of 224 presumably typical ammerical dietary studies vere calculated, the average protein content was found to be 106 m., or 140 percent above the indicated maintenance requirenent of 44 gm., while the average calcium content was 0.74 gm., r 64 percent above the estimated actual minimum of 0.45 gm. n contrast to laboratory evidence, clinicians find that many merican and English dietaries are much more deficient in calium than they are in corresponding amounts of protein. There re many cases, too, in which the kind of protein or the intake f some particular amino-acid is unsatisfactory.[34]

THE VITAMINS AND METABOLISM

Obviously the vitamins are constituents of plants; plants are oods; foods are necessary to nutrition; and therefore, the vitanins are bound up in some mysterious way with plant and human ell metabolism. For want of a better term, they may be called italizers. They probably energize food elements and influence netabolic vigor. They are recognized by their absence rather han by their presence. Loss of appetite in a child is an illustraion. The reason for this lack of desire for food has long been matter of conjecture. Recently clinicians have concluded that vhen no apparent cause can be found, there is a deficiency of itamin "B," a condition which may also be influenced by age, ace, and stock.

Osborne and Mendel, in 1917, pointed out that the stimulating ffect of vitamin "B" on the appetite was not simply an improvement in the palatability of the food mixture. Improvenent in appetite naturally leads to the increase in food conumption, and, in the young, to an aroused growth impulse and growth. They showed definitely that appetite, the stimulaion of vitamin "B," and growth are related.

It was noted experimentally that for some time after vitamin was withheld from the diet of rats their appearance remained bout the same. They were lively, sleek coated, and bright-eyed. radually their fur lost its gloss and the animals themselves ecame lethargic. Following this the rats become thin and pale, ere cold to the touch, and remained huddled in corners away om the light. Similar conditions occurred in dogs, but when itamin "B" was returned to the food ration the appetite reived and there was an increased food consumption.

Workers in this field have discovered a relationship between vitamin "B" and the digestive secretions, as seen in gastric and intestinal atony. McCarrison has mentioned an impairment of the intestinal contents along the alimentary canal as among the effects of the lack of vitamin "B." Its deficiency may also be responsible for constipation in older children. Many biologists claim a relationship of vitamin "B" and size, metabolic rate, oxygen consumption, the metabolism of various food constituents, a lowered temperature, and respiratory difficulties.

All the other vitamins exert important influences on metabolism. Their abundance or absence can readily be seen by the trained clinician.[35]

THE ROLE OF VITAMINS AND OTHER NUTRIENTS IN MINERAL METABOLISM

The keen observer has undoubtedly noticed that nature endeavors to assist the various organs and bodies in their motivities. The following may be a case in point, although it has no specific reference to children. In recently published metabolic experiments on normal women, there was observed a noticeable lowering of the total calcium excretion and a correspondingly favorable influence on the calcium balance during those periods when either yeast or butter fat was added to a basal diet very poor in vitamins. These facts suggest some kind of compensating relationship between the vitamin content of the diet and calcium.

Bogert and Trail found it advantageous to follow the magnesium and phosphorus metabolism of their subjects during the same interval, in order to see whether the yeast or butter fat exerted any similar influence simultaneously upon the metabolism of other inorganic constituents of the diet. The magnesium and phosphorus balance in two normal women was found to be favorably influenced by the addition of yeast to a diet of white bread, rice, lean beef, skim milk powder, purified nut margarine, sugar, and starch. The calcium balances determined over the same period in the same subjects were similarly affected. A third subject failed to show improvement in calcium or magnesium balance by the addition of yeast to the diet, although the retention of phosphorus was favored under the circumstances. The substitution of an equal weight of purified butter fat for a vegetable fat in the basal diet led to diminished fecal output and an excretion of magnesium and phosphorus, with a constant intake, but on the whole the balances of these elements

ere favorable in all four subjects studied. In every case the alcium balances showed a simultaneous improvement, the metabolism of these three elements being closely parallel throughut the experiment. One must admit that the effects produced y the yeast and butter fat may have been due to factors other han their vitamin content. At least this illustration does show he harmonizing effects of life's processes.[36]

CONGENITAL NUTRIENT STORAGE

In estimating the percentage of calcium suitable for the growth nd development of the infant and child, it is well to remember hat a storage of calcium and other nutrients must take place o that these biologic processes may continue uninterruptedly. Vhen there is a deficiency of calcium storage at birth, a later ttempt to supply the demands of the organism is putting the art before the horse. It is obvious that the adequately nourished nother will send her child into the world with better nutrient ood storage than will one suffering from malnutrition. It is, herefore, of especial importance to try to estimate the amount f calcium received by the infant from its mother before birth nd during the suckling period. If possible, it is also well to now at what time during growth calcium must be stored in rder to provide for the normal development of a child's body; ow much the relation of body calcium to body weight normally changes with growth and development; whether age coninues to be a factor after growth and development have been ompleted; and, lastly, whether the bearing and the suckling of he infant has reduced the store of calcium which the mother hould have acquired during the growth and development of he fetus.

Although answers to these questions were drawn from the xperiments of Sherman and MacLeod on rats, and although heir conclusions are approximate to similar values in infancy, ne may divine a strong relationship between the two. The alcium content of the white rat was established by the analyses f large numbers of animals at definite ages. In round numbers, he percentage of calcium in the body was found to increase rom 0.25 percent at birth to about 0.6 percent at 15 days; about .7 percent at 30 days; 0.75 to 0.85 percent at 60 days; 0.95 to .1 percent at 90 days; and 1.0 to 1.2 percent in the adult animal. From this we sense the importance of proper foodstuffs or the infant as being at least somewhat related to the nutrition f the mother.

At the age of 60 days, the gross weight of calcium in the bod was higher for male than for female rats, since the average weigh of the males was greater. The increase in weight and percentag of calcium was found to be rapid up to 90 days. Both for male and for females which had not raised young, there was a slowe but steady increase from 90 days to 8 months. It was found, toc that before the age of 120 days there usually occurred a dis tinct lowering of the percentage of calcium in the bodies of th females as the result of the bearing and suckling of their young Thus we have reason to believe that there is in the huma mother a tendency to lose body calcium during the periods o lactation and a tendency to regain it during the intervenin periods.

Animals which had received ample calcium but were stunte in growth because of other deficiencies in the diet—lack of vita min "A" or "B," or too little protein—in all cases had highe calcium content than normal rats of the same weight, but les calcium than normal animals of the same age. Animals whic received sufficiently little calcium in their diets lost calcium fron their bodies. We wonder if the nursing mother is able to de velop according to the standard for her age and at the sam time give the required milk calcium content to her child, if sh is deprived of foods containing a sufficient quantity of minerals

In a series of experiments with various diets, it was founc that when one percent of calcium lactate was added to a diet the percentage of calcium in the body was raised to the norma figure. In order that the infant may receive the required cal cium, both the diet of the nursing mother and the compositior of the artificial milk modification should have a comparativel high mineral content.[37]

GROWTH, BODY BUILD, AND METABOLISM

The questions most frequently asked pediatricians regardin the care of children are those relating to growth, body build mental and physical development, and longevity.

Basal metabolism may be considered the sum total of all the vital activities of the organism at rest—the minimum, or mainte nance metabolism, which is unaffected by extraneous factors Using this basal metabolism as a keystone or foundation in out lining growth and development, one may then measure definitel the effects of superimposed metabolic advances. The factors de termining the height and weight of the child are so subtle, espe cially during the years of adolescence, that one must approac

em with care and research. We do know that the normal
fant makes its greatest gain in weight during the first five or
x months of life, when it almost doubles its birth weight. If
e increase in weight during the first five or six months is one
undred percent, it averages only about fifty percent in the
cond six months. During the second year of life, the increase
weight diminished to approximately twenty-five percent and
the third year, to less than twenty percent. The percentage
increase in height also becomes less and less with increasing
ge.

When we speak of growth, we mean skeletal growth plus the
ldition of flesh. Among the numerous agents which affect
owth are nationality, environment, social status, and the quan-
ty and quality of food. All around us we see the children of
any races, some inclining to height and physical development,
seen in the Anglo-Saxons, others typically leaning to short-
ess, as the Japanese. Growth curves are by no means identical,
en in children of similar races, and of similar localities. For
stance, in London, the average weight of infants, male and
male, was found to be much higher than that of the infants in
eeds. Undeniably, those children who live out of doors and
hose families can afford to supply them with good and sufficient
od enjoy a better growth and development than do the less
vored ones of the same race and nationality, but who do not
njoy those benefits. Again, even food and physical environment
e not entirely responsible for a dwarfed growth. Germ plasm
efects, somatic irregularities, infected teeth, enlarged and dis-
sed tonsils and adenoids, are some of the other considerations.
rdinarily, open air exercise is advised to promote an increased
od consumption, yet sometimes one must not insist upon too
uch of it, as the underfed child automatically restricts its energy
r vigorous exercise, since he needs energy for growth.[38]

The eating habits of children often puzzle us. One must not
nfuse peculiarities of oxidation with the eating habit alone.
enetic qualities provide children with different types of con-
tution, so that one fourth of them may have a large appetite
d consume great quantities of food and thus manufacture fat;
ile in the other three fourths a constitution which provides
small appetite in turn leads to light eating, and thus to the
anufacture of protein rather than fat.

As there are constitutional differences in the appetite, so there
e vagaries of metabolism, both unreservedly inherited traits.
he following case is an example. A professional man writes
at his brother, of medium build and of about seventy inches

in height, consumes daily around 2,700 calories of food. T physician himself and his sister, both being of the obese ty consume about 2,500 calories each, while others in his fami group who are of medium height use about 2,000 to 1,800 calori The doctor's work is confined chiefly to the laboratory a office. He drinks on an average three to four quarts of water day. His son, now nearing eleven years of age and weighing ju above one hundred and twenty pounds, is sixty-three inches ta and fairly stout. The boy is very active and is constantly urg to eat, but he likes to miss a meal now and then and usual declines a second portion of food. Indeed, he eats much le than his six-year-old cousins who, for their age and racial i heritance, are undersized. This lad, the son of a man of lar build, has never been a heavy eater. He affords an instance, often met with, of an easily fattened type in whom a slight exce of calories produces a striking result in build, a dominant cha acter inherited from his father.[39]

The child who exercises to excess and metabolizes a lar amount of food, usually grows in height but does not gain i weight, for enough extra food has not been added to enab him to do so. It is increasingly evident that added food as suc cannot but do harm.

Happily, scientists have concentrated our attention on t vitamins which have been found to play an important role i skeletal growth. If they are absent, there is a diminution growth, but development goes on and is not particularly altere Osborne and Mendel have observed this phenomenon in whi rats. Jackson and Stewart have found that although differe organs in the body did not maintain this normal relative weig during inanition, yet after proper food was given the organs r sumed their natural growth, and attained adequate size. In th darkest spots of many cities, both here and abroad, the writ has seen apparently hopelessly rachitic children transformed int strong, healthy athletes through scientific nutrition.

In studies of height and weight, food deficiencies may embo two distinct factors; first, the absence of those vitamins whic promote growth; second, a caloric deficiency which shows itse in the loss of body material previously stored during the grov ing period. In fact, if the height is equal to that normally foun for that age, but the weight is too low for the height, one ma look for caloric deficiency. The calories ingested are not su ficient to take care of the heat output, and while the food inta may be ample for normal exercise, a deficiency in growth occu with strenuous exercise.[38]

RELATIONSHIP OF HEIGHT TO WEIGHT

The best indication of the state of nutrition, then, is the ratio of height to weight. A normal, an average, and an ideal state of nutrition may be recognized in this ratio. It has long been acknowledged that the body weight alone in reference to age is not an ideal indication of the normality of the child's state of nutrition. Many investigators have considered height as well as weight in reference to age, while others have added girth of some part of the body. Admitting, for the time being, that normal height indicates a normality of nutrition, we may ask, what is normal height?

The range of height in boys and girls is very indefinite and there seems to be no such thing as normal height. In adults the difference between normal and average is clearly recognized and the mean is taken as normal. In children, age, weight, and height are closely correlated. As children grow older they increase in height and weight.

Racial characteristics are indicated clearly in height. When a child is short for his age, it indicates one of two things; either he is the offspring of parents of normally short statures—a dominant inheritance; or there is a serious deficiency of growth-producing factors in the diet. When animals or humans are maintained upon a diet of constant caloric value during the growth period, the skeletal development is achieved at the expense of existing tissue. Thus, one should beware of accepting the average as normal.

Underweight is more common than overweight. On the basis of age, a child of normally short stature with an accompanying small body weight might be considered underweight; but if this short stature is the result of racial dominance or recessiveness, and not of a deficiency in growth-promoting factors in the diet, the child may be considered normal. Neither an average height for age nor an average weight for age is an index of the nutritional state, as the height may be accompanied by varying weights, and vice versa.

It is therefore clear that the relationship between height and weight is the most satisfactory index of the best proportional distribution of flesh to the skeleton. In the normal development of the child, growth proceeds with a considerable degree of regularity, and usually at a certain rate of rapidity. In a favorable environment, children grow in skeletal form at least as well as in total weight and more rapidly than in a poor environment.

Many persons lay more stress upon underweight than on under

height. Statistics have shown that youths under thirty years of over average weight have a greater expectance of life than do others of under average weight. Beyond thirty-five years, however, a weight under average insures a better life expectancy. In our experience, a moderate underweight would seem at times to be more advantageous for children than a little overweight.

METABOLISM AFFECTED BY GROWTH

Experience has shown that the physiologic activities of a child by no means can be represented by a straight line, or even by a regular curve indicating function, for there arise gross irregularities which are inherently a part of physiologic life. One cannot base deductions on one child alone, but upon the average metabolism of several children. The basal metabolism of an adult as measured from month to month, from year to year, from twenty to thirty years, let us say, does not vary much as a result of a change in age, and usually there is no material change in weight or height. But in children, rapid growth and changes in stature and weight make it illogical to average the values found for any child during a considerable range in age, and then to consider that the result represents the true average value for that child. Is not a child of one year one individual, and a child of even one and one half years quite another? The daily basal metabolism tests are subject to great fluctuations. Thus, when children are considered as a class, the gross differences in age, weight, and stature make it extremely difficult to find two children of exactly the same age, weight, and height. As a rule, boys are more active physically than girls; they are also less controllable and they do not easily acquire the habit of repose. Observations indicate an increasing metabolism rate continuous from birth to thirteen years of age in both boys and girls. Age and body weight go more or less hand in hand. Their curves show a relationship between total calories and age, for as children grow older they grow heavier, and a larger body has a larger heat production. In a group of individuals of identical weight, the taller ones have a higher metabolism. On the other hand, in a group of individuals of equal stature, the heavier children have the greater metabolism rate. While a heavy adult carries a large proportion of inactive fat which does not materially contribute to heat production, this does not hold true in children. Nature provides that younger children have usually a much larger proportion of fat than have older children. In

oung children, incidentally, it is difficult to determine at exactly hat hour the stimulus of the previously ingested food ceases, and ne point at which the stimulus of the ever-occurring incipient cidosis begins. While height and weight have independent in-uences upon metabolism, body surface, with its rather close elationship to weight, likewise has an apparent relationship. ince body surface represents more nearly general morphologic ıws of growth than does body weight, the relationship between ccurately measured body surface and metabolism is frequently ıuch closer than between body weight and metabolism.[38]

INFLUENCE OF SEX AND SEXUAL CHANGE ON METABOLISM

Physicians cannot fail to notice the wide differences in activity nd dietetic habits of boys and girls, and there are striking varia-ons between the metabolism rates of the children of both sexes. lany of the earlier comparisons disregarded body weight and nsidered age only. It is impossible to compare a twelve year d boy weighing thirty eight or forty kilograms, with a twelve ear old girl weighing perhaps thirty kilograms. Andral and avarret believe this sexual difference is even more pronounced etween the ages of sixteen and forty. The exhalation of carbon oxide alone by a man during this latter period is twice that a woman. These same authors maintain, for instance, that puberty carbon dioxide increases suddenly to large amounts boys, while in girls this excretion suddenly ceases to increase nd remains stationary until the menopause. In men, it de-eases at the approach of old age. Magnus, Levy, and Falk state at the total metabolism of boys during the years of puberty es not exceed that of normal adult men. Indeed, in some boys e metabolism rate was found to be less, while in others it was proximately the same as that found in adult men. These ientists concluded that the gaseous exchange in children per-its of weight greater than that in adults, being proportionate the age and weight of the child. This, however, does not ply to the first year of life.

Some authors even believe that metabolism is the same in th males and females. Sonden and Tigerstedt do not concur this belief, however, and remind us that females have a lower etabolic rate. In younger children the gaseous exchange per logram of body weight for girls is somewhat less than that for ys. However, in larger children this gaseous exchange is about

the same in both sexes. Caution should be exercised in considering that any particular normal child may indicate a fixed normal metabolism rate to which all other normal children of the same age, sex, height, and weight should conform. The individual child may vary so greatly from the so-called average, that extreme care must be used in interpreting the deviations from rule as having a pathologic significance.[38]

INHERITED QUALITIES

It must not be inferred that growth, body build, height, weight, and development are dependent wholly on somatic conditions. Genetic qualities, whether dominant, recessive, or atavistic, predestine children to slimness, tallness, shortness, and to weight differences. The soma merely emphasizes these vagaries of build. "Skinny," "short," and "fatty" are some of the euphonious nom-de-plumes which classify their bearers long after puberty.

This great variability of transmitted characters is probably most strikingly seen in the numerous types of body build. The importance of a specific type of body build is recognized in the realization that each type has its own rate of metabolism. Each type requires its particular kinds of foods both as to quality and quantity, and possesses its own caloric and nutritional tolerance. From the matings of slender parents spring predominantly eighty-four percent of slender and of very slender offspring. From the mating of two obese or very obese parents three percent of the offspring are slender, but not extremely so. The ranges overlap somewhat, for the slender matings produce sixteen percent of progeny which are above slender build; while the obese matings produce thirty-two percent of children which are below the obese build. The progeny of the matings of slender types are much less inclined to variability than are those of the obese matings. These facts are of great importance in the study of nutrition. From the standpoint of genetics, much of what has been said would indicate the presence of more genetic factors in the obese parents than in the slender. The hybrids, however must be considered also.

When multiple factors are concerned, the resulting generation has not the same uniformity as when only one factor is involved. To illustrate, one can understand offspring arising from the mating of very obese with slender stock, obese with very slender and obese with slender inheritance; while even subdivisions of these may be transmitted. Various compromises are necessary because of too small numbers of offspring on the one hand, and

heterogeneous parentage on the other. The fact that certain brid children are slow in developing their potential maturity body is of great interest to the student of genetics; but of perps far greater significance to the clinician are the variable etabolism rates, as seen in children of different body builds d of different inheritance states.

When a slender individual of slender stock is mated with an ese individual of obese stock, it is interesting to note, that of spring under observation, the proportions are six slender, enty-eight medium, fifty-five fleshy, and eleven very fleshy. Innces ad infinitum might be quoted of the many variations body build inheritance. Individuals of medium build, for e most part, are not heterogeneous hybrids, but belong to a stinct biological type.

In spite of the few examples of cross matings, already enuerated, and of the much larger number of matings between oss and lean stock, tabulated by Davenport, it is by no means sy to determine the number of independent factors which are tive in the case of a trait due to these multiple factors. It is en more difficult, however, if there is only a very imperfect minance, approaching intermediacy of the trait, in the progeny a particular mating. When these multiple factors are invoked explain genetic inheritance by the appearance of a trait, it n be perhaps explained on the theory of blended inheritance. venport concludes that the inheritance of body build in the ild follows the Mendelian theory of inheritance only. One may stinguish particularly two principal types of variation in the ild of a child. First, what may be termed the ontogenetic, or e change in normal build during the child's development with increasing stature; and second, the change in the weight of child with a relatively invariable stature. In the first class, e stature and other proportions rapidly change; but in the cond, the stature remains practically constant. All through e the stature changes as much in mature persons as it does in is child. When the pediatrician measures the child under obrvation as to height, chest circumference, length of bones, size cranium, girth of abdomen, etc. and compares these figures th those measurements considered normal for that particular e, he is often astonished at the marked discrepancies. His onishment will often be abated, however, in his questioning the parents as to identical conditions in their own infancy. rict scientific data as to measurements in body build are very portant and extremely necessary, for these measurements and her findings tend to give certain data regarding the laws of

ontogenetic changes in build from birth to maturity. Such data may be employed as a ratio in formulating a law for tracing the change in build of a developing child, or for tracing the average build at successive years of life. In the adult the stature is practically fixed, and at this period one finds that changes of build are measured by the relative chest girth, as in children.

Sex influences the body so profoundly that one must look for differences in build depending on sex. At birth the male infant is about 2.5 percent heavier than the female child. In 1902 Doffner showed that German male infants at birth weighed on an average 3,310 grams, as compared to 3,230 grams for the females. Benedict and Talbot, in 1915, found birth weights for American male children, 3,606 grams and 3,485 grams for the female, the male infant being not necessarily chubbier, yet 1.7 percent longer than the girl baby. In later infancy no obvious differences are detected, says Davenport, but unfortunately no strictly scientific studies seem to have been made at this later period. Geographical variations have also been noted. Both the white and Eskimo children near the pole are found to be heavier than those at the equator, due possibly to a lowered disease rate which favors an increase in weight.[39]

THE PRENATAL CHILD

In the prenatal body of the child, the biologic cells favor an independent growth under normal conditions. This growth at first is quite generalized in character, but later becomes localized first in one part and then in another, at which stage the child requires special food properties contained in the blood stream of the mother. This generalization ceases about ten days after birth, but subsequent to the specificity of these cells, all growth may be considered an enlargement of performed organs and tissues dating from heredity.[40] Later on, in many instances children are subject to numerous structural variations.

CLASSIFICATION OF INFANTS AS TO BODY BUILD

The attempt to classify infants according to their body build is a provokingly hard task, yet Ledered, in 1923, divided them into four groups:—the *muscular,* those with strongly developed muscles, a round head, broad shoulders, and large chest; the *digestive,* with small nose depressed at the base, a large mouth, a broad lower jaw, and large abdomen; the *respiratory* type

ith broad nose and large chest; and the *cerebral,* with large ead, narrow shoulders and chest, and long narrow fingers. Posbly, for the sake of less burdensome clinical observation, these pes had best be narrowed down to two, the *linear* and the *teral.* The infant of the former class possesses a long narrow ead, a long face, a small lower jaw, a high, narrow nasal bridge, arrow palate, a long thin neck, and a small chest circumference. ıch infants, the author believes, tend to underweight. The cond or lateral type, on the contrary, has a round head, a short ce, a large lower jaw, a low, broad nasal bridge, broad palate ounded anteriorly, a short, large neck, large chest, broad shoulds and hips, and short stubby fingers with short nails. These fants put on weight easily. Many types seen in older children ay be somewhat similarly classified. Our own clinical observaons seem to confirm the belief that these types interchange or end, and that only in older children can one be certain of stinct groupings, when hereditary traits and characteristics nd to reach their maturity.[40]

GROWTH, BODY BUILD, AND PUBERTY

With the supposition that simplified and systematized data ay be more easily understood through figures, chest-girth charts e appended. A glance at these tables will show that at six eeks the infant's body has reached its maximum chubbiness, but about the eighth month a loss occurs, due to the cutting of e incisors. Every parent is perceptibly reminded that at about e twelfth year the boy enters the awkward age, his arms and gs having grown from five to ten centimeters in a single year, though they have not attained their full muscular function. is trunk however, has retained its childish proportions. The tle girl enters the "bachfisch" stage of similar slenderness and kwardness, and for the time being, her emotional instability comes a problem to parents and teachers. The influence of e endocrines at puberty, particularly the pituitary gland in th boys and girls, is seen in the long bones and in the apndages. Usually at about fourteen years, when the gonads gin to ripen, the growth of the legs is retarded and the transrse chest diameter increases rapidly. The high relative chest cumference of infants is due chiefly to the extremely short gs. For the leg length contributes only about forty percent of e stature at birth, whereas at maturity it constitutes from fiftyree to fifty-five percent. Consequently, the relative leg length infancy is only a trifle more than seventy percent as compared

with that of the adult. The relative length of the infant's arm is only eight percent less than that of the adult. The white race has its greatest leg length shortly before adolescence. It is of passing interest to note that the adults of the long-legged Negro tribes of East Africa, especially on the Upper Nile, seem to represent, according to Johnston, the physical stage through which the white boy passes at twelve years.[39]

ANALYSIS OF GENETIC FACTORS

In tabulating the distribution of alterant builds, of unharmonious organs, and of internal structures in general, a large mass of family data is required, often disclosing ancestral skeletons, genetic heirlooms which also include many irrelevant types of build and body structure, and which, to be worth while, must be more reliable than many families admit and consider necessary. This, frankly, is no problem when dominant characters are transmitted from generation to generation, as is seen in some families where the parents are all slender or all obese and where the heart, endocrines, brain, and other internal structures are functioning in the offspring much as they did in the progenitors. All these factors have to be transposed to the ordinary methods of genetic analysis, and they all seem to follow to a marked degree the Mendelian hypothesis. The following records have been chosen by Davenport from the best available series of nationalities represented chiefly in the United States.[39]

TABLE 1

RELATIVE CHEST GIRTH OF ELEVEN INFANTS DURING FIRST TEN DAYS OF LIFE

Age from Birth	Average Relative Chest Girth	Average Relative Chest Girth X 1.03
at birth	642.65	666
1st day	645.86	670
2nd day	646.76	671
3rd day	635.86	659
4th day	634.78	658
5th day	634.54	658
6th day	635.66	659
7th day	629.20	652
8th day	633.91	657
9th day	631.98	655
10th day	633.20	657

TABLE 2

AVERAGE RELATIVE CHEST GIRTH OF INFANTS FROM BIRTH TO THIRTEEN MONTHS

Age	Average	Number
eeks	6627	39
eeks	6410	144
nonths	6745	210
onths	6512	133
onths	6382	104
onths	6507	88
onths	6368	79
onths	6540	344
onths	6456	318
onths	6450	279
onths	6333	276
nonths	6400	250
nonths	6318	225
nonths	6260	322
nonths	6222	295

Figure 1 build-curve shows that in males the build is greatest birth or somewhat later, then steadily diminishes to twelve rs of age, when it again slowly increases to maturity. The ant at birth has a chest girth somewhat over two thirds of stature. This falls rapidly during the first month, then bes to rise. This minimum is connected with the loss of weight ich follows birth, due to the difficulty of the body in making justments to new conditions. This adjustment is completed thin two months.

Further variations according to body type, growth, and age older children are given in these charts of Sherman.

RATE OF GROWTH FOR BOYS OF SCHOOL AGE

Age—Year		6	7	8	9	10	11	12	13	14	15	16	17	18	19
erage	(short)	43	45	47	49	51	53	54	56	58	60	62	64	65	65
ght	(medium)	46	48	50	52	54	56	58	60	63	65	67	68	69	69
ches)	(tall)	49	51	53	55	57	59	61	64	67	70	72	72	73	73
erage	(short)	3	4	5	5	5	4	8	9	11	14	13	7	3	
ual	(medium)	4	5	6	6	6	7	9	11	15	11	8	4	3	
n in	(tall)	5	7	7	7	7	8	12	16	11	9	7	3	4	
ght (lbs.)															

RATE OF GROWTH FOR GIRLS OF SCHOOL AGE

Age—Year		6	7	8	9	10	11	12	13	14	15	16	17	18
Average	(short)	43	45	47	49	50	52	54	57	59	60	61	61	61
height	(medium)	45	47	50	52	54	56	58	60	62	63	64	64	64
(inches)	(tall)	47	50	53	55	57	59	62	64	66	66	67	67	67
Average an-	(short)	4	4	4	5	6	6	10	13	10	7	2	1	
nual gain in	(medium)	5	5	6	7	8	10	13	10	6	4	3	1	
weight (lbs.)	(tall)	6	8	8	9	11	13	9	8	4	4	1	1	

METABOLISM OF PLANTS

No study of child nutrition would be complete without a similar exploration into the metabolism and growth of plants. A study of this nature fits in with our conception of the prevention and cure of disease and the establishment of sound health in infancy and childhood through nutrition, for plants and their products are basal foods.

Heredity in plants follows a plan corresponding somewhat to that of the human family, but while in plants nearly all the species engage in mutual fertilization through pollen grains, human procreation is vastly different.[41] The greater part of the child's food must necessarily come from the earth directly, a minor part indirectly. All nature points out the relationship of plant metabolism to that of the human. Since the higher and lower animals in general are dependent directly and indirectly upon plants as a source of their food, it may be of interest to probe into the biologic nature of plant growth. Green plants contain carbon, hydrogen, oxygen, and nitrogen, simulating the make-up of the human body. From the ash of plants, sulphur, phosphorus, potassium, magnesium, calcium, iron, sodium, chlorine, and silicon have been abstracted by laboratory methods. Iodine, bromine, fluorine, and many other elements have been discovered. All these elements used by the plant must be obtained from the air, water, and soil. If the first mentioned elements are not available, the normal development of plants is not possible. Except for oxygen, all the remaining elements are used in the form of compounds. The carbon is derived from the carbon-dioxide of the air, while hydrogen and oxygen are utilized in the form of water. Oxygen is secured in combined form from the air or from its solution in water, and is found

nbined in many salts and oxides. Nitrogen is utilized by most nts in the form of nitrates, and one of the chief sources of this rogen is ammonia (NH_3), one of the products of the bacterial composition of organic material derived from the bodies of nts, animals, or animal excrement. The nitrogen of ammonia made available to green plants through the action of certain cteria which transform the ammonia into nitrates, while other cteria transform the nitrites into nitrates, and as such the rogen can be metabolized by the green plants. Leguminous nts, such as beans and clover, have nitrogen-fixing bacteria ich are seen as nodules on their roots. Sulphur is taken into nts in the form of sulphates, phosphorus in the form of phosates, while potassium, magnesium, calcium, iron, and other ments are found in the form of various salts in solution. rbon, in the case of submerged plants, derives its carbon xide from its solution in water, while carbon dioxide, in n, is the product of the oxidation of organic matter.[42]

The soil is made up of particles of gravel, sand, and clay of ying degrees of coarseness. These particles are of mineral gin, produced by the breaking down of various kinds of rocks ough the action of water, snow, or ice. Plants obtain most of ir mineral foods from the clay, but almost none from the d, which is largely made up of quartz.

When leaves, straw, roots, and other plant materials decay, when animal wastes such as manure are added to the soil, y give to the earth substances which are stored up in their oths and which originally sprang from it. This decayed animal l vegetable matter, or humus, is a dark-colored top soil, loose l easily penetrated by air, water, and by the roots of plants. e composition of this humus is a biologic factor in plant trition. Distributed in the finer particles of rich soil, and espelly on the surface of it, are found important chemical comunds useful to the growing plants. Among these necessary npounds one finds sodium nitrate, potassium nitrate, sulphate lime, phosphate of lime, and iron chloride. Where the humus found fertile, the waters of brooks, creeks, and rivers have ssed over and through the underlying soil and have dissolved aller or larger amounts of mineral matter, depending, however, the solubility of the minerals present. The sun, the ultimate rce of energy, acting upon green plants brings about the proction of food substances which are able to combine with oxygen d so release the energy.

Light, air, and moisture of certain kinds and character, as ll as favorable temperature for specific species, are essential

to plant growth, and plants can manufacture carbohydrates onl in the presence of sunlight. Oxygen is necessary for the germina tion of seeds. Also the right kind of soil must contain nitrogen potassium, phosphorus, and calcium in large amounts; and in proportion as these elements are decreased, just so much is the plant deficient in the nutritional principles which make eventu ally for the health of children.[43] Good soil contains not onl lime, potassium, iron, silica, and organic material, but it con tains also nitric acid and carbonic acid, which so act upon certai mineral substances that they become soluble in water.

A large amount of water must be taken up by the roots in orde that the plant may get the needed percentage of mineral matt with which to build up its protoplasm. Within the human bod are found bacteria, and in the roots of plants, located withi little nodules, may be found millions of bacteria also. The take oxygen from the air and prepare it to be used by the plan in other words, they form nitrates. Roots also absorb oxyge from the soil and from surrounding moisture. The greater th amount of good plant protoplasm for growth, the more an better protein will be available for children's food. Protein i present in the leaves, stems, and roots of plants. The plants tak in water and dissolved mineral salts from the soil; the leave take in carbon-dioxide from the air; and the water and salt taken in by the roots are conveyed to the leaves, where th synthesis between the carbon, on the one hand, and the elemen of water and of nitrates, etc., on the other, is affected. The de struction of the carbohydrates, oils (fats), and proteins thu synthesized in those plants results in the staple products of ou markets.

Starvation of lands which are used for food stuff productio and without subsequent replenishment of the soil often create a very unfortunate economic situation. Such fields are deprive of their mineral salts for plant supply. The more the plants ar deficient in them, the less will be the adequate nutrition of th cow, and the poorer its flesh and milk. In time, cows grazing o fields naturally or artificially fertilized but without sufficient re plenishment, will exhaust these localities and thus bring abou the result that the animals are taken farther and farther awa from an easy access to communities using their milk. The con sequence, of course, is higher milk prices.[44]

FERTILITY OF SOIL

Weeds are the natural enemies of plants used for food, and re, in consequence, hostile to the child, for they threaten its food upply either directly from the earth or through the poor milk an ill nourished cow. These enemies to the plant are useless, armful, and stubborn; they are bullies, thieves, and murderers, or they drain the soil of its nourishment, thereby starving the lant. Weeds are moreover hardened savages, they can resist extremes of temperature, endure drought, grow in poor soil, resist isease, and produce enormous numbers of seeds to germinate nd further rob the soil. Among them are the black mustard, umble weed, pigweed, ragweed, and many kinds of grasses.[43] itrates and phosphates, as well as the soluble salts of potassium, re often scanty in many soils, and in small communities one ees the fruits of this deprivation in mal-nourishment. Nearly ll the minerals, with the exception of silicon, sodium, and hlorine, are indispensable to green plants. The idea of reorestation is being firmly established in the minds of the people nd it is to be hoped that a mass soil refertilization project may ollow, for the use of plant growth is the primary requisite in aintaining the fertility of the soil.

One might mention many concrete instances of malnutrition children, even in country districts, which are traceable to tarved out fields and stricken cattle. American farmers are far ore backward than are European peasants, in that they often epend upon natural fertilization, thereby taking from the soil ith no thought of replenishing it.

Abandoned farms of fairly good size in New England and in ther parts of the country are ghosts of soil ignorance, yet other arms nearby, though rocky in character, are naturally refertilized rom the rocks which, being rich in phosphates, are available for lant use. Micro-organisms and many kinds of bacteria contain ungi, and the bodies of small field animals may be present in ood soil. Some of these bacteria are concerned with fermentaion and with putrefaction, while others are concerned with the hanges of nitrogen and sulphur in soil fertilization.[1]

SOIL BACTERIA

One might just as well speak of a child as normal from the tandpoint of environmental factors alone, quite omitting nutriion, as to speak of a healthy plant growth unaided by soil bac-

teria. It matters not what other agencies are at work in harmony in the plant's growth, if favorable bacteria are not present the plant is lacking in ordered metabolism to the extent of being of no nutritive value in the development of the child. Soil bacteria are of four varieties:—

(1) nitrifying bacteria, (2) nitrogen-fixing bacteria,
(3) denitrifying bacteria, (4) sulphur bacteria.

Nitrifying bacteria are concerned with the changing of ammonia compounds into usable nitrates. They may be divided into two groups:—the first group utilize ammonia and oxidize it into nitrous acid compounds called nitrites; the second group oxidize nitrites to nitrates. The contrast between the nitrite and nitrate bacteria in higher plants is striking. Higher plants depend on complete carbon compounds for energy to carry on metabolism, and they use this energy to transform simple nitrogen compounds like nitrates into complex ones, which constitute an important part of their protoplasm.

Bacteria, however, are just the opposite. They can utilize only simple compounds of carbon, like carbon dioxide. This they build into such complex forms as they require, with the energy derived from oxidizing nitrogen compounds. Furthermore, they leave the nitrogen in just those compounds which are required by the higher plants. Both nitrite and nitrate bacteria thrive best in alkaline soils and are injured by wet, acid soils, because they take free atmospheric nitrogen and unite it with hydrogen and oxygen from water to form complex compounds, and this reaction is one in which energy is stored up. Curiously enough, the bacteria derive their energy to do this and to carry on all their other metabolic activities from the oxidation of the carbon compounds, such as sugar, which occur in the soil, being derived chiefly from the remains of plants consisting largely of cellulose and similar materials. Through the activities of these bacteria, added supplies of nitrogen compounds are made available to the soil. Indeed, they supplement the work of the nitrifying bacteria which change the already existing compounds of nitrogen to simple nitrates. They cannot do their work in the presence of soluble carbohydrates.

The *denitrifying* bacteria reduce the nitrates, and do best in wet and poorly aerated soils, which means that they break up compounds and liberate nitrogenous gas.

Sulphur bacteria are interesting in that they are taken from the soil in solution as a compound of sulphuric acid, and combine with the proteins of other compounds of plants and animals.

ılphur is liberated in putrefaction as hydrogen-sulphis and is tilized in this form in certain soils by water bacteria, which xidize the hydrogen to form water and store the sulphur in neir bodies.

There are also other varieties of bacteria which demand passng attention:—(1) free, living soil bacteria, (2) types living mbiotically with algae, (3) those living symbiotically with cerin leguminous plants in root tubercles, and (4) certain fungi alled mycowhiza, or living symbiotic roots of a number of trees nd shrubs. The first, through suitable cultivation, multiply and nrich the soil everywhere, their bodies being rich in nitrogen. he second kind live under surface layers of soil, lowly algae eeding nitrates. Bacteria of the third type are found on the oots of leguminous plants, seen as swellings called nodules or ıbercles. Inside them are numerous bacteria of a special kind. ight in these nodules bacteria fix the nitrogen, deriving their nergy to do so from the carbon compounds of the root cells. he mycowhiza are masses of fine filaments of a certain kind of ıngi which attack the roots of certain trees and shrubs. They enetrate well into the root and abstract from it organic carbon ompounds.

CYCLES

In plant chemistry there is in use a specific term known as ycle. One finds, for instance the carbon cycle. It is clear that most the only source of carbon in organic compounds containng it is the carbon dioxide of the air. This is combined with ater by green plants to form foods and fuel, the source of energy f all living things. In their metabolism these plants oxidize arbohydrates and fatty foods to carbon dioxide and water. This arbon, withdrawn from the air as carbon dioxide by green lants, is eventually returned to it.

The nitrogen cycle permits the same nitrogen to be used over nd over again. Found in the atmosphere, it is made available y nitrogen-fixing organisms and accumulates in the soil by the ctivities of these organisms. The nitrites are taken up by green lants and are combined with sugars, as well as with sulphuric nd phosphoric acid, to form amino-acids and proteins, which re used, in turn, to form living protoplasm and to repair waste.

Next we have sulphur and phosphorus cycles, in which the ılphur is taken up by plants as sulphuric acid compounds and uilt into protoplasm, reappearing during the putrefaction of ead plants and animals as hydrogen sulphide. Eventually it is

restored to the soil as sulphates by the action of sulphur bacteria. Phosphorus, however, enters the plant as phosphate and becomes a part of its cells. At their death and decomposition it reappears as phosphoric acid and unites with lime to form phosphate again.

Finally we reach the energy cycle. Derived from the sun as light, energy is locked up in food and fuel. When liberated by metabolism or combustion, it reappears anew in the form of energy, as heat and mechanical work. It is never in a form to be utilized directly by green plants.[5]

THE INFLUENCE OF IRRIGATION WATER ON THE COMPOSITION OF GRAIN AND THE RELATIONSHIP TO NUTRITION

If one were to travel cursorily over parts of New England, England, France, Germany, and other countries, he would be surprised at the aridity of many farm lands. This conclusion might be verified easily, not only by his eyes but also by the toe of his shoe. Rivers, brooks, and irrigation projects may all be missing. Yet this irrigation water, from whatever source and however formed, is indispensable to the soil, for not only does it govern the quantity of grain grown on a unit area but it governs the quality as well.

It is illogical to believe that the child gains the same amount of nourishment from its breakfast cereal or from its milk modification uninterruptedly. Experiments conducted at the Utah Experimental Station give us a clear insight into grain variation. These experiments are related to the ash, nitrogen, phosphorus, potassium, calcium, magnesium content of wheat, oats, and barley, all grown in the same soil, but with changes in moisture content. The surface acre-foot of the Greenville Experimental Farm contained 4,904 pounds of total nitrogen, 2,700 pounds of total phosphorus, 60,560 pounds of total potassium, 434,365 pounds of acid-soluble calcium, 132,463 pounds of acid-soluble magnesium. It is probable, however, that the calcium and magnesium occur in the soil mainly as the double salt form $Ca\ M_9(CO_3)_2$, magnesium-carbonate being present in such small quantities that it is not harmful.

It was found that the nitrogen content of wheat decreases as the quantity of irrigation water increases. There was 0.416 percent less nitrogen in the grain grown on land securing 20 inches water over that grown on non-irrigated soil; and the total quantity of nitrogen contained in the non-irrigated grain proved to

43 percent higher. The tendency seems to be for the total nds per acre in the various grains to increase up to a certain ximum as the irrigation water increases, after which there is ecline, a very pronounced one, in oats and barley. The quan- of water which remains at the surface and can be utilized the growing plant is in the same order as the increased nitro- in the plant. The oats showed a very regular decrease in percentage of nitrogen as the quantity of irrigation water reased. The oats raised in a non-irrigated soil contained 39 cent more nitrogen than those grown in soil receiving 45 nes of water. Barley followed the same law. This decrease in ogen with an increased irrigation is probably due to two ons; first, the irrigated grain, due to its greater demand for ogen, was not able to obtain a sufficient amount from the ited supply of the soil to build a high protein grain. Indeed, conclusion is borne out by the findings of Gericks, that a n protein grain can be produced by keeping a ready supply itrates within reach of the growing plant. Second, the appli- on of large quantities of irrigation water during the growing on washes the nitrates beyond the feeding powers of the s.

was found, too, that where the water was applied in small uent applications, the protein of the grain was high as com- ed with grain grown on land receiving small quantities of er in large applications. The small, frequent applications, vould seem, bring the soil up to an optimum for a rapid ification, but they do not carry the nitrates beyond the feed- area of the roots, hence the higher protein grain. Applica- s of large quantities of water to the more mature plants have ter effects in reducing the nitrogen content than have the lications earlier in the growing period, because it is during period of mature growth that a full supply is necessary to d the high protein grain. Within certain limits, the ash of grain of wheat, oats, and barley increases with an increase rrigation water.

n the feeding of farm animals, cows for instance, in which production of bone is considered, the irrigated grain is su- or. However, what concerns the pediatrician is whether or the watered grain would be more valuable in bread. The e of the morning cereal to the child depends upon whether milling process is leaving the same quantities of ash in the ered grain, and whether the excess of ash is more valuable n the excess of protein in the non-irrigated grain. Children in d of more ash in their diets can well be given the irrigated

grains in preference to those not receiving irrigation, althoug
they would be getting less protein.

Wheat, oats, and barley all show a gradual progressive ir
crease in phosphorus as the quantity of irrigation water used i
their production increases up to thirty-five inches yearly, bu
above this there is a decrease. In the case of wheat, the increas
amounts to 55 percent, oats 35 percent, and of barley 30 percen
This means that it would require for a 50 bushel crop of whea
4.9 pounds, a 100 bushel crop of oats 2.9 pounds, and a 75 bushe
crop of barley 4.2 pounds more of phosphorus if grown wit
large quantities of water than if grown with small quantitie
The increased phosphorus content is probably inorganic, and nc
composed of the phospho- and nucleoproteins, which would be
less value to the child.

However, this extra phosphorus would not be without value b
any means, for cows kept on grain diets which had been grow
on irrigated soil would probably find the extra quantities su
ficient to build strong bones and to modify the calcium an
phosphorus content of the milk. This would, in turn, modi
the nutritive value and thus the digestibility of the milk. It
very likely that the increase in the phosphorus content of th
milk is associated with an increase in the available phosphoru
of the soil, for as the water content of the soil increases, up to
certain level, there is a proportional increase of the soil micr
flora, which would increase the quantity of acids. These aci
liberate phosphorus from its soluble form.

When the optimum moisture is exceeded, there is a propo
tional decrease in bacterial acids. This, then, would result
less available phosphorus, which would be manifested in a grai
with a lower phosphorus content. Wheat is modified in pho
phorus content to a greater extent than either of the oth
grains. It also carries greater quantities of total phosphorus fro
the soil with all the irrigation treatments than do either oa
or barley, and reveals itself as an excellent food for infants ar
children.

The percentages, also, of potassium in the wheat were foun
to increase progressively with the water applied, so that by th
time it was receiving 35 inches of irrigation water it was at th
same time carrying 35 percent more potassium than was th
wheat grown with no irrigation water. The ratio of phosphor
to potassium where no irrigation was used was 1 to 1.34. Th
ratio, however, became wider as the water used increased to
inches, when the ratio was 1. to 1.53, while above this it gro
narrower, and wheat grown with 67.5 inches of water had

ospho-potassium ratio of 1 to 1.26. It can be readily seen, erefore, that water has a greater influence on the phosphorus ntent of wheat than it has on its potassium content.

The oats increased in potassium content as the applications water were increased. Those grown with 45 inches of water ntained 31 percent more potassium than those grown without igation. The ratio of phosphorus to potassium in the oats was oved to be wider than in the wheat, and the variation in this io was in the same order as with the wheat.

The barley increased in potassium as the irrigation water in- ased up to 20 inches, but above this there was a decrease. ater increased the potassium in the wheat by 35 percent, which s less than the increase in the phosphorus content of the eat. Under the same conditions the oats increased 31 percent; barley 14 percent, all because of this irrigation water. The io of phosphorus to potassium in the barley was discovered be narrower than in the wheat and oats, but followed the ne order of variation. This is usual in these grains, thereby licating that the same law is operating in all three grains in uptake of phosphorus and potassium, and is quite probably related with the available constituents of the soil, while both re rendered more soluble by an increased bacterial activity due an increased water content of the soil. Then too, the calcium ntent of the wheat increased as the water increased, and was nd to be greatest under small applications, and approximately nstant for each increase of five inches of water up to 20 inches. heat raised with 67.5 inches of water contained 255 times as ch calcium as did wheat raised without water.

Certainly such differences as these must be significant in our oblems of nutrition in infants and children, for where the ole grain is utilized children are getting much greater quan- es of calcium. The oats, too, showed an increased calcium ntent until the irrigation water reached 20 inches, for with inches and above there was a steady decrease. With an in- ased water supply, barley gained in calcium content. For ample, that grown with 52.5 inches of water contained 1.41 nes as much as that grown without water. Then again, the io of the calcium to the phosphorus was found greatest in the ley but least in the oats. Marked uniformity was shown be- een the increase in calcium and of phosphorus of the various ins when grown with an increased water supply, thus indi- ing that the increase is deposited as inorganic salts.

Again, the magnesium content of all three grains increased as water increased. Wheat showed an increase of 32 percent;

oats of 65 percent, and barley of 9 percent. The magnesium-phosphorus ratio in all samples was; for wheat 1 to 1.91, for oats 1 to 1.87, and for barley 1 to 1.84. This is much narrower than is the calcium-phosphorus ratio, which appears as follows:—wheat 1 to 2.19, oats 1 to 2.09, and barley 1 to 2.88. The calcium-magnesium ratio grew narrower in the wheat and wider in the oats and barley also, as the water increased.

Irrigated cereals can carry sufficient calcium and phosphorus to produce strong, normal bones in children, which is not the case with corn alone, and without other sources of inorganic salts. It is possible that the variations in the amounts of these salts and the differences in children may be correlated with this large variation in the ash content of the grains grown under different conditions of irrigation. Moreover, there may be cases of children living even on restricted rations, in which the greater quantities of minerals contained in this irrigated grain may be quite sufficient to prevent nutritional disorders; though admittedly on the border line, which may occur where the dry-farm grains are used.

We cannot ignore the significance of feeding children with moderate kidney disorders the irrigated grains, for they may be getting from 26 to 46 percent more ash than if fed on dry-farm products. Whether the dry-farm grains are considered more nutritious depends entirely upon the balance of the remainder of the diet, for it should not be overlooked that a ration low in protein is more adaptable from non-irrigated grains; but if low in ash the irrigated grains have proven superior.

There is then, to sum up, a great fallacy in an over-irrigation from the standpoint of the soil fertility, for it depletes the soil in two ways:—first, it washes out soluble nitrogen, which is a limiting factor in soil fertility, in an arid region particularly, for it is in this wise that a low protein grain is produced; second, it causes the grain to take up larger quantities of potassium and phosphorus than it otherwise would, thereby unnecessarily depleting the soil.[45]

CROP PRODUCTION

The great American tragedy is not that of the stage or screen but is to be found in the fields, in the general unawakened conception of soil replenishment. The writing on the wall, seen dimly or not at all for so long, now stands out like a transparency. If the myriads of children yet unborn are to grow and develop, are to rule, there must be soil rehabilitation. The farmer should

e encouraged to consider his land a primitive nutritional laboratory. The physician, quite unlike the farmer, is interested in crop production from a nutritional point of view rather than from the exchange measured in dollars and cents.

Modern methods have outlived the ancient ones. The modern and far-seeing agriculturist, instead of allowing his rich lands, after the harvest, to remain fallow and return immediately to natural fertility, has found that through crop interchange, for instance, through changing some of his grass lands into potato or corn lands, he can increase his crop production. This has a distinct bearing on nutrition in rural communities. It is a fundamental principle in crop production that the environment must suit the crops, and although there is no hope of controlling climatic factors, yet it has been made possible to mitigate their effects by modifying the environment. Thus one can appreciate that the foods for infants and children should not all come from one section. The scientific farmer modifies the environment in four ways:—first, through drainage—often an elaborate engineering problem—by removing an excess of water, thus making the soil drier and therefore warmer; secondly, by a method known as chalking, which neutralizes the acidity of the soil and improves its texture; and this flocculating clay facilitates the cultivation of all crops and increases their yield; thirdly, the farmer in sowing his lands increases or decreases the water and air supply of the roots of the plants which modify soil temperature; fourth, by increasing the amount of plant nutrients in the soil, as seen in the inorganic salts, which fall into three divisions supplying nitrogen, phosphoric acid, and potash.[46]

GOOD PASTURAGE: GOOD MILK

Following soil starvation and a succeeding faulty plant nourishment, it is but a step to disordered metabolism in animals, high or low, children or cattle. A study of this character is of vital importance, especially when one realizes that the quality and quantity of calcium and phosphorus in milk from cows whose living comes from rich or from poor soils does or does not balance with the other food principles; does or does not nourish the bones and teeth; does or does not stimulate growth and development; and does or does not aid the biologic activities of the cells, so necessary to their proper functioning. Meigs and Turner have thrown considerable light on the necessity of good fodder for cows. They contend, and rightly so, that a full-nutrient milk is dependent upon good soil and a generally healthy en-

vironment. In their experiment, the calcium, phosphorus, and nitrogen balance of milk from two cows was followed continuously for a period of 175 days. During the whole of this time the animals were fed liberal portions of grain, to which was added various kinds of hay; timothy and two grades of alfalfa. One of the grades of alfalfa was cured without exposure to rain and to only a short exposure of sunlight. Cod liver oil was added to the three weeks ration. The other lot of the alfalfa had been allowed to lie in the field for one week, and it had been rained on for nearly two days before being dried. The first lot, the good alfalfa, contained between two and three percent of calcium, the second lot, the poor alfalfa, contained no more than two percent, the timothy about 0.3 percent, and the grain about 0.15 percent. When the cows were fed the good alfalfa they remained close to calcium equilibrium, but on the poor alfalfa combined with timothy hay they lost calcium rapidly. As in the child, the phosphorus metabolism followed that of the calcium in a general way. In the course of 133 days, the cow fed on a poor alfalfa and timothy hay diet, the one which was giving the largest amount of milk, lost about 1.3 grams of calcium, or about 19 percent of the total normal calcium of her body. At the end of this period, that cow was giving ten kilos of milk daily but losing calcium from her body as fast as in the beginning. Daily, during a 21 day period, both cows were given the ration of grain and of poor alfalfa plus 100 cc. of cod liver oil. This did not, however, improve the calcium assimilation in either cow, yet it did produce a noticeable increase in milk yield in one of them.[47]

SPECIFIC ILLUSTRATIONS OF SOIL CONDITIONS

Every economic disturbance of whatever kind of character, of whatever country or community, gives valuable suggestions. During the world depression there developed a situation in many countries probably unparalleled in history, where hunger and misery stalked nakedly within formerly prosperous homes. In younger countries, notably the United States, these troubles were unprecedented and wholly unforeseen. Men's minds turned from ennobling philosophies to radicalism, and then to food. There was a large outpouring of people from the thickly populated communities to the farm country. "Back to the Farm" become a popular slogan. This means that in many communities people have finally awakened to the realization that the soil, rich and

productive, is the source of economic, physical, moral, and mental health. Thus, with the more studious and practical brains of the working class focussed on the soils of their respective communities, it will not be long, before crops of grains, fruits, and vegetables will be planted and encouraged in soils previously thought to be unsuited to their production. In the end this will bring profit to infants as yet unborn.

In glancing over data concerning soils of the United States, we pause a moment to study two nearby communities, as recorded by the Bureau of Agriculture. One is White Plains and the other, Tompkins County, both in New York State. These soils are generally representative, not only of this section, but of other areas as well. Tompkins County is situated near the centre of the state, and is approximately 24 miles from north to south and 23 miles from east to west; it comprises 304,640 acres. The variant soils of this territory are badly in need of drainage, of refertilization, and of deep plowing.[48] A soil survey of the White Plains area, which is situated near New York City, shows that there are not enough products raised to supply the demand. Marked neglect is seen in fruit culture, the apple trees especially being for the most part old and receiving very little pruning or spraying. The soil of this area is derived from glacial source, from stream deposits of miscellaneous earths, and from recent alluvial sediments, rich and generally productive.

There are many things which the American farmer might learn from his European neighbor, among which are causes, effects, and cessation of soil activity; the injurious results of the soluble salts of aluminum, iron, and manganese upon crops grown in acid soils; the causes and effects of a removal of alkalinity from certain soils. The farmer must study the oxidation, reduction, nitrification, and denitrification processes, by which the organic matter of the soil is transformed by bacteria and other agencies.

The chemical composition of the water which is used for both land irrigation and the watering of live stock is of great importance in milk modification problems. Chemical analyses and field tests of fertilizers, of potassium salts, and the perfecting of nitrogen fixation methods, as well as the relationship of sulphur to soil fertility, must all be closely studied.[49]

Manures and fertilizers, as well as organic matter, considerably alter the texture of the soil and its power of holding water. Studying soils in a general way is an innocent, but at least a fruitful hobby. For illustration, compare the soils of Germany

with those of England. In Germany a large amount of the soil is light and sandy, needing potash, while in England, with its loamy characteristics, no such necessity arises.[46]

DIGESTION IN PLANTS AND ANIMALS—AN ANALOGY

Digestion, as decreed in the organism of the child, has a close resemblance to that of the plant. Living matter, be it plant or animal, cannot make use of foods until these foods have been rendered soluble and diffusible through protoplasm. In the plant cell, starch must be brought into solution before it can be utilized in building up protoplasm. Proteins and fats cannot be used while they remain merely proteins and fats, for neither can diffuse through the colloids of the cell. In the animal cell the same state of affairs exists. Therefore digestion is the process of bringing foods into solution and into a state of diffusibility by means of chemical agents. These agents are employed by plant and animal cells alike, during the process of digestion, and are solutions elaborated by the protoplasm. In truth, the power of producing digestive solutions is possessed by all living cells. These solutions are either acid or alkaline. In addition, there are important substances called enzymes, and, as in the human organism, so in the plants, the chemical nature of these bodies is not wholly known. They have the property of hastening chemical reactions by entering into the formation of intermediate substances from which they are promptly released. Much as in the case of the human organism, these plant enzymes are affected by heat and cold, and most of them probably act best at a temperature of from 60 to 75 degrees C. Certain of them are rendered active by small quantities of free acid, while others act best through alkalis, but ions of certain metals inhibit their action.

In both plants and animals, we find a similarity in three classes of these digestive enzymes; namely, the amylolytic or carbohydrate splitting, the lipolytic or fat splitting, and finally the proteclytic or protein splitting. The lipolytic enzymes of both plants and animals break down the fats into glycerol and fatty acids, both of which are diffusible. Soluble soaps are formed by combination of the fatty acids with bases, and these and some unaltered fats are absorbed. The proteolytic enzymes, whether of plants or animals, may be classed as peptic enzymes, if they require the presence of acids to make them chemically active, or tryptic enzymes, if they require an alkaline medium. The most important enzyme in humans, as in animals, is pepsin.

This substance in the plant splits proteins into peptones and peptides. These bodies are not diffusible, however, and are further broken down by trysin, completing the splitting of the proteins into amido-acids and other compounds. After foods in the plant have been rendered soluble and diffusible they are absorbed. This occurs through the protoplasm adjacent to the vacuoles in protozoa, or through the protoplasm adjacent to the reserve food in the cells of higher animals and plants. The products of digestion in both these living bodies pass through the protoplasm by osmosis, the protoplasm acting as a membrane. Having been absorbed, the simple substances produced in the digestive process are re-combined and built up into living protoplasm, perhaps through the agency of the enzymes.[42]

FOODS FOR PLANTS

A further similarity between plants and animals is seen in the basic food principles common to both. These elements are carbohydrates, proteins, and fats. In order to build up proteins, carbon dioxide, oxygen, water, and organic salts must first be combined within the plants into organic compounds. These, in turn, constitute nutrient substances, but are not really foods. The plant cell, like the human biologic cell, manufactures much more organic food than is ordinarily required by it, and this reserve is stored in the fleshy roots, stems, leaves, and seeds.[42]

FOODS FOR CHILDREN

Children make use only of this organic food that the plants have stored away. This means that they receive from the plants the nutrient elements; carbohydrates, proteins, oils or fats, as well as certain substances called albuminoses, which somewhat resemble proteins. In addition are two food elements of inestimable nutrient value to the growing child; one of these is seen as small quantities of much needed salts, and the other as vitamins. These vitamins, of chemical nature, though not fully defined in all cases, are found abundantly in fresh, leafy vegetables as well as in some other foods, less plentifully in the cereals, and not at all in the vegetable oils. Vitamins are absolutely essential in the child's diet, and even though foods with a high caloric value are given, the absence of vitamins will cause malnutrition. The sugars found in fruits and some vegetables, and the starches in flour, fleshy roots, plant stems, and fruits, are examples of the carbohydrates supplied by plants.[42]

THE SOURCE OF VITAMINS

At the present time humanity is passing through a period of vitaminic unrest. From advertisements and display cards the unthinking may easily conceive the source of vitamins as springing from a can, bottle, or container, from some favored yeast cake, some form of candy, or from somebody's vitaminic foods. The source of vitamins, however, lies in the plant, whether of the land or the sea, whether in the fish as cod liver oil, or whether in the cow as milk.

An attractive little experiment by Karshow, Krasnow, and Harrow illustrates the contention that the source of the vitamins may lie in the plant. They showed a seed vitamin, in synthetic form, during the germination and greening of corn. Fifteen rats were kept on a synthetic diet deficient in vitamin "A" until they became stationary in weight. To the diet of the first five (Group A), there was added the equivalent of six seeds of ungerminated corn per rat a day. To the diet of the second five (Group B), there was given the equivalent of six seeds of germinated corn per rat per day.

The diet of the third five (Group C) was reinforced by the equivalent of six seeds from green seedlings per rat per day. Within 81 days after the corn feeding had begun, all rats in groups A and B contracted xerophthalmia, and eight died. All the rats in group C were found to be in excellent condition and gaining in weight. The average weight of each ungerminated seed was 0.17 grams, germinated, 0.16 grams, and the green seedlings, 0.11 grams. Although the rats in group C weighed less than the others, they thrived. It can be reasoned, therefore, that during the process of greening there is a synthesis of vitamin "A." Similar illustrations of other vitamins might be quoted.[50]

ACTIVITIES OF THE VITAMINS

Vitamins vitalize the food principles within the cell and bring about possibilities of cell activity through their intimate co-relationship with the incoming food nutrients extracted from the coarser food by way of the digestive tract. It is impossible to believe that the vitamins, as such, could in themselves alone exert any dynamic influence upon the organism through the cell, unless they were biologically enrolled into the fabric of metabolism and attached themselves to certain elements, much as the steel tines to the magnet. In plainer language, the vitamins must be

wrapped up in foodstuffs only, and to try to use them unaffiliated after segregation to relieve deficiencies certainly may render them less valuable.[50]

VITAMINS IN THE FORAGE OF THE COW

The value of a fertile soil, of rich pasture land, with the resulting well-ordered metabolism of the plants grown there, and of the cow which feeds thereon, cannot be too strongly emphasized in connection with the nutrition of infants and children.

In the long fight for clean, nutritious milk, such details as the cow, its breed, its nutrition and handling have assumed an impressive significance. Much attention has been given to the source of its food and to its environment, and many things have been discovered. For instance, it has been found that the green plant tissue contains more of a certain vitamin, one which aids in calcium assimilation, than that plant tissue which has been exposed to long curing processes. Alfalfa hay, when fed as a supplement to the grains and grain by-products, may, however, be cured so that it retains its quantities of this vitamin in sufficient amounts to maintain healthy, free-milking cows in a satisfactory calcium and phosphorus balance.

The airing of hay under caps lessens its efficiency and certainly renders its quality unequal to that of green alfalfa. The embryo farmer does not take into consideration that the maintenance of a calcium and phosphorus equilibrium in lactating cows, or the storage of these two elements, is accomplished only when the green salt material is supplemented with a calcium salt, or where the phosphorus is amply provided through fodders of wheat, bran, or other like products rich in phosphorus.[51]

ULTRA-VIOLET RAYS AND MINERAL SALTS IN PLANTS

Plant food-nutrients and human food nutrients are developed, then, through the aid of the sun's rays, particularly ultra-violet rays. These ultra-violet rays are useful in preventing bone disease, rickets, and associated diseases, by raising the calcium and phosphorus content of the blood. According to Beeskow, the effects on plants are equally beneficial. He grew groups of soy bean plants in solutions of known mineral composition. Varying groups were subjected to irradiation for different periods, other groups being kept as controls. The plants were then dried and analyzed for calcium and phosphorus. He found that the irradi-

ated plants had noticeably higher contents of these important inorganic salts than had the corresponding controls.

Irradiation may prove harmful to children as well as to plants. A too short wave length of the vapor lamp or a treatment of too long duration may be injurious to children. Beeskow mentions that soy beans planted in a greenhouse showed the effects of the duration of exposure to direct ultra-violet irradiation, even if the treatments varied only one minute every other day. A distinct reddening of the parts of the stem and leaves penetrated by the rays was noticeable, and this coloration increased as the dosage increased. This damage to the plants was greater when the under side of the leaves was exposed to the rays, for then the heavy overdose killed the plants.[52]

SUNLIGHT AND SHADE

Attention to those phases of environment which make the creation of vitamins and other nutrients possible, is an important study. Radiant energy from the sun is received in almost inconceivable amounts by both plants and animals. The sun's rays are all of different length and are capable of doing different kinds of work. For illustration, the combination of carbon dioxide and water to form sugar (OO_2 H_2O $C_6H_{12}O_6$) is made possible through the sun's rays, and this supply is absorbed by the green parts of plants, the absorbing agents being the green pigments in the cells near the surface of the plant bodies.

This radiant energy underlies the manufacture of all fuels as well as foods. Plants certainly may be shaded out of existence, and this fact seems to be true of many children. Such plants die without having fully developed, much as do children. The sunlight reaching the earth's substratum may, on many farms, be insufficient in quality as well as in quantity, may even lack the necessary rays, and may affect the plant only through its heat-producing qualities; however, under normal conditions, its activities, actinic in nature, energize the soil around the plant root.[1]

The great necessity of fertile and productive farm lands in the nutrition of infants and children may be seen in the expression of these rays as a factor in the proper development of plant metabolism, and when absent, as a cause for plant mal-development.

Wheat grown in the dark was found, by Hess and Weinstock, to be devoid of anti-rachitic potency. That grown in light and then irradiated with a vapor lamp possessed an anti-rachitic protection. Similar observations were made with lettuce and other vegetables.[53]

Agriculturists tell us that seedlings grown in total darkness are most yellow-white in color, their leaves but slightly developed, d their stems advanced to far greater extent than the leaves. he hunger of plants for light is known to every flower lover and seen in the tendency of the plant to grow toward the light. enerally speaking, warm regions produce the more generous d luxuriant growth, while the cold of the high mountain gion has an inhibitory effect.[54]

HUNGER IN PLANTS

It may seem fantastic and visionary, in the study of plant life connection with human nutrition, to ascribe to plants certain ualities and certain senses which are supposed to be only biologic ases of humans. Kniep courageously attributes to them the nse of taste and also of smell, due, he believes, to bacteria, and eks to show that the response of bacteria to certain chemical imuli depends upon the reaction of the culture medium. He elieves that the quantity and quality of the food are important ctors in this response.

The swam cells of the spore-producing plants appear to feed phagocytosis just as do the unicellular animals, and it is ossible that this feeding phagocytosis in plants is influenced by unger in much the same way as children are influenced by unger. With the exception of some of the bacteria, the swam lls of the shorophytes, the group of "parasitic" plants, and, to a rtain extent, the so-called "carnivorous" plants, the vegetable ganisms feed primarily on the inorganic material in the soil d on the carbon dioxide of the air. In these feeding processes e motility of the plant, apart from its growth, plays a minor rt.[55]

RESPIRATION

All living things, both plant and animals, require oxygen in eir metabolism, which is useful in the organism in the decomosition of the constituents of protoplasm, and probably also of ored proteins, carbohydrates, and fats. This process of comning oxygen with protoplasmic substances and perhaps with her substances as well, is what may be termed true respiration, d occurs in the protoplasm of the cell. True respiration, alike plants and animals, results in the production of carbon- oxide and water or else of certain other intermediate com-

pounds, as well as in the release of energy commonly expressed in the form of heat and motion.

Thus, little by little, one may see a closer analogy between child and plant life. Such a process as this is not a synthetic but a destructive process, yielding for the most part carbon dioxide and water as end-products. In plants, there takes place a constructive process called photosynthesis, in which carbon and water as raw materials are elaborated into carbohydrates by the chloroplasts, which employ the energy of light for this transformation. By this process energy is stored. In respiration, the oxygen consumed is found in the oxidation of elaborated foods. Energy is released, the by-products being carbon dioxide and water.

Plants have other relationships beside those of a merely metabolic nature. They have, in fact, an ecologic relationship, in that they adjust themselves to the conditions in which they live as do children. Children and plants are dependent upon certain physical conditions, such as food and water and different environmental requisites. Some animals require an aqueous medium, others a solid; some plant food, others, animal. Some animals and plants require particular climatic conditions, and these are absolutely essential to encourage the particular species of both biologic bodies.[42]

PLANT ENEMIES

The economic importance of plant disease, resulting in poorly nourished and defective plants, is not to be underestimated in the search for available plant nutrients for infants and children. The lessening or throttling of plant growth and the diminution of crop output may have evil consequence, particularly in those communities subsisting on questionably fertile soils.

From the estimate of the United States Department of Agriculture that the loss by plant diseases in recent years was 190 million bushels of wheat, 200 million bushels of corn, 86 million bushels of potatoes, and 18 million bushels of apples, one can readily realize how much less food is available for consumption. Rust and scab caused a great deal of this loss. The causes of plant diseases may be external to the plant, or lying within it; or, again, they may consist in unfavorable features of environment externally, or of interference by other organisms. Where the environment is unsuitable, it is often found that the soil is either alkaline or acid. In certain parts of the far west the presence of unusual quantities of sodium or calcium salts makes the soil alkaline. In areas of excessive moisture, on the contrary,

e soil may be acid as a result of acid solutions formed in the urse of the decay of organic waste.

Exceedingly hard soil favors the inception of disease, in that interferes mechanically with the growth of plant roots, and excessively wet soil proper aeration is prevented.

Farm gardens situated in the neighborhood of large cities feel ese effects strongly, for solid particles may form an opaque ating on the leaves of the plants and so prevent the absorption light by the chlorophyll-containing cells. Sometimes very dden changes in the barometric air pressure cause plant disease; midity or a sudden dryness bring the same result. Sudden dry-ss often burns young foliage and sudden humidity causes so ich of a change in the cells and tissues of the plants that uptions develop.

In summary, heat, cold, light, shade, or prolonged exposure to matic changes may produce disease, shown as a color change the foliage or in the untimely falling of the leaves.

The internal physiologic causes of plant diseases are not so ar. Plants may grow too rapidly or may tend to crowd each ier, in which case there develops a deformity called "fascia-n." Worms may attack roots and other parts of the plant and ison it through their excretions. In the spring, flies often posit their eggs in the young tender bark of growing stems. ant parasites and fungi which cannot make their own food ovide themselves with nourishment by robbing other organisms by living on the products or remains of other organisms. This uses physiologic disturbances of the host; examples are vine ldew and onion mold. Another example is the minute fungi iose spores either infect the grains or are scattered from the rent plant and thus infect young plants through interfering th their food manufacture.

Then too, if the soil is very dry the plant obviously suffers from k of moisture. These various unfortunate conditions produce normal or diseased plants, for they disturb their normal ysiologic activities. The result is an unhealthy growth, a sened crop production, and invariably, extreme malnutrition the children living in these localities. A more graphic picture the sequelae of plant starvation may be obtained from books scribing the lives of the so-called poor whites of the south.

When it is realized that both alkalinity and the acidity of the l may be alleviated by tillage, and not through nature alone, American system of land culture suffers on comparison with it of the European peasant, for while the American is liberal the use of water and fertilizer, he gives, as a rule, but scant

attention to the physical condition of the soil. Deep plowing, as done in Europe, keeps down weeds, exposes fresh surfaces to the action of air and light, and tends to bring the food rudiments to the surface of the soil where they can be utilized more readily by the plant.

Polluted air, such as is found near localities where industrial plants such as coal or ore mines are situated, may cause chemical injury and disease in plants, for the sulphurous vapors arising from the burning furnaces or from the smelting of ores may seriously affect plant life. Still again, there may be pollution of the air by solid particles like soot. Also, dust from the roads or from quarries not only detracts from the purity of the air, but reduces the amount of light which reaches the earth's surface.

There may be smuts, or a bacterial invasion, as seen in pear blight, characterized by an infection of the inner bark which causes the flowers to abort, thus seriously diminishing the quantity of fruit. Wilts sometimes appear, and root tubercules of bacterial origin are occasionally seen in the roots of leguminous plants. Usually, however, these bacteria are of great benefit, for they fix the free nitrogen of the air, thus adding to the soil nitrogenous compounds of the utmost value.[5]

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CHAPTER 9

PERTINENT FACTS IN INFANT NUTRITION

THE GOAL of nutrition is immunity. This goal, however imperfectly realized, requires the skillful handling of foods, and the correlation of environmental factors which make food fundamentals available for activating metabolism, thereby harmonizing organic function. There can be no immunity without this harmony of forces.

Nutrition is the means to maintain health, to build up, strengthen, and develop desirable inherited and somatic potentialities, and to modify, weaken, or destroy undesirable tendencies. However, owing to the germ plasm imperfections, perfect nutrition can never be attained. The word nutrition covers a multitude of sins, gross exaggerations, and misconceptions, while the contrasting term, malnutrition, as commonly understood, is narrower in scope. Then too, the word nutrition is a collective term and concerns many phases of the child's life not accredited to it by the laity. Its interpretation is quite at odds among varying groups of peoples, and misconceptions, ignorance, the pseudo sciences, tribal, racial, and religious conceptions, all enter into its meaning. Precocious, unhealthy, maldeveloped, over-fat, rickety, anaemic, and blowsy infants are paraded before us on the radio, in the street cars and busses, or in colored pictures, sucking at somebody's mild oil or tablets. Sad cases of mental or physical over-development are reported by loving parents or featured in lay journals and magazines not so loving.

Before attempting the study of foods and of their specific qualities necessary to preserve health and to establish growth and development, as well as to cure disease, we shall survey the broader field of general nutrition and the nutritional problems which confront every pediatrician.

Could a dream of healthy children born of equally healthy stock come true, and could the social and economic maladjustments of the times be changed so that mothers might be able and willing to nurse their own babies, there would be few nutritional problems of infancy. Problems of immunity, of disease resistance, would be simplified, for such a mother would biologically carry her infant over to those months when artificial feeding could be resorted to without danger. The mother of today is prevented

m nursing her child not so much on account of social and nomic conditions, but from the influence of modern times. leed, consciously or unconsciously, she is influenced by her roundings to resort to artificial feeding rather than to natural thods, in the belief that she cannot furnish milk of good ality and quantity. There is no doubt, however, that in eptional cases the economic stress of the times has prevented stitutionally sound women from suckling their infants. At same time one often wonders how much food advertisements, lth lectures, radio broadcasts, and strictly laboratory-minded sicians have abetted in this curtailment of a natural function. Could science in the past have controlled preceding generations modern medical methods, fewer dysfunctions from parental hilis and from other toxins might have been transmitted, er alcoholic or sexual excesses might have occurred to darken lives of so many succeeding little innocent children.

uch dysfunctions may be roughly divided according to our nomenclature into three divisions:—minor, intermediate, major or gross dysfunctions. The minor dysfunctions prove easiest to treat, the intermediate rank second, while the gross functions are the most severe, and usually fall into the hands other specialists. In consequence, we have not attempted to sider them in these pages.

Iinor and intermediate dysfunctions, or their potentialities, ge over a wide field of organic disturbances, and in their gress arouse many perplexing problems, especially if their rse is not interrupted by recognition and skillful treatment. word "minor" barely conveys its characteristics; rather it is aritable term for little, mean, perverse, and nagging qualities nheritance and of the soma. Such dysfunctions may slyly ear as a hyper- or hyposecretion of the gastric juice, so that in latter instance the child may belch and vomit after the estion of milk. Indeed minor irregularities may show themes in almost any organ in the body, commonly as petty disturbes which throw the child's organism off balance. Minor unctions may often be ferreted out, but the intermediate ety is more frank and appears oftener in the open, and is sequently subject to diagnosis and scientific tests. Gross unctions may thrust themselves wantonly forward and by r very coarseness and hideousness may repel those unfamiliar them. One often wonders if the so-called functional diss, so characteristic of certain organs, are not the result of a ciency of some nutrient in the blood stream which feeds the of those organs exhibiting a functional disturbance. Perhaps

there is a deficiency of some elements which affect the central cells of the nervous mechanisms which motivate their functions. Possibly also these symptomatic functional changes may not only be caused by a deficiency of nutrients, but in some cases by an excess of improper nutrients which the cells of the affected parts cannot utilize and which throw them out of alignment. These deficiencies and excesses have a way of influencing behaviorism in the child and of causing many little, but apparently uncontrollable, temperamental outbursts. The great biologist, Czerny, always maintained that proper nutrition had a great influence on the exudative diseases specifically. He too speaks of excesses in the child's diet and notes its organic susceptibility to an excess of milk and egg in the diet as a disease provocation. We have observed this same sensitiveness to meat and eggs, but rarely to milk. The increase in the number of scarlet fever cases following the World War resulted, as Czerny firmly believed, from the deprivation of milk and eggs.

Furthermore, improper nutrition as a result of the selection of wrong foods, unsuitable environment, seasonal changes, climate, life in the city or country, life at low or high levels, social, economic, physical, and psychologic conditions, and many other factors, strengthen or reduce the child's resistance to disease. One child may have a tendency to disease in winter, a second in summer, a third in the spring, and a fourth may succumb in the fall. It may happen, as seen in our experience, that a child will not fall a prey to disease at any other time than at its own seasonal period. Cattle and dairy men tell us that there is a marked seasonal variability in the nutritive properties contained in milk and in the meat of cattle, while farmers and horticulturists point out a similar difference in plants, grains, and vegetables. Therefore, is it not probable that if certain parts of the earth undergo nutritional changes at seasonal periods, children nourished on their products may lack certain nutrients in their food at these periods of the year? These deficiencies obviously lower the functional capacity of the biologic cell. Incidentally, it has been observed that the greater growth in children has occurred in July and August, the increase gradually lessening from September to January, when the deficiencies in food nutrients become marked.

Scientific nutrition depends on nature and on agriculture for its realization. It is owing in part to the disturbances of plant life, directly or indirectly, that inherited dysfunction potentialities, from which many somatic diseases originate, are fostered. Rickets and scurvy, possibly purely somatic in character, are seen more generally in the spring, as are many severe nutritional

orders, especially after a long, hard, dark winter. Many foods lacking in vitamins in the early spring, before the sunshine, rmth, and flowing water have replenished the earth to nourish roots of plants.

Iany factors in nutrition and in seasonal environment tend to nge certain body activities. Straub, Meier, and others believe t in the winter season there is a lowering of the carbonic acid tent of the blood, so that, in consequence of a changed piratory rate, it becomes acid. From autumn to winter, more aline substances are at the disposal of the child's organism n in the period from spring to summer. A large number of se functional disturbances are remedied by scientific nutri- ı.[1]

utritional diseases tend to cure themselves if carefully se- ed foodstuffs are given in proportionate amounts and the ironment is suitable for their metabolism. Food, plant, and al poisons in lethal doses, however, may counteract beneficial lencies. In those long continued chronic nutritional diseases, with those inherited gross dysfunctions, the outlook for cure ften a dismal one. Basal cells may be impaired or even royed, and cannot be regenerated. Instances of this cell airment may be seen in extreme malnutrition from foods er too rich or too poor in necessary nutrients. In some cases, n proper nourishment and environment, many badly dam- l cells may, partially at least, return to something like normal ction. With a more active oxidation of food stuffs, there is ncreased outpouring of energy, with a resultant growth and elopment of the formerly impaired organs and tissues of the l's body. The increased metabolism shows itself specifically ne renewed activities of the skin capillaries, as sweat secretion, y heat, and hyperanemia. One may visualize, too, in this roved nutrition, each organ as having its own kind of unity, and possibly, under favorable conditions, every ryo, and every ovum, from the moment of fertilization may ire it.[2]

hile nutrition is considered a general term, malnutrition, on whole, may be considered as a relative one.[3] Rickets, scurvy, ny, osteomalacia, laryngospasm, and spasmophilia, associated tetany, are cases in point. They are all members of a family p and are the result of a disharmony of calcium and phos- rus in the blood. Deficiencies of needed vitamins, proteins, carbohydrates, and inorganic salts, cause cellular changes, h in turn bring about special types of nutritional disturb- s, many of them fleeting, functional in character; but at other

times, these changes may arouse potentialities of minor dysfunctions which, in time, become of major significance.

To the layman, the most characteristic signs of malnutrition are recognized in the various abnormalities of the teeth and gums, because of a deficiency in the blood of the various nutrients necessary to their proper growth. What minor functional derangements resulting from food deficiencies are taking place in the internal organs as well, is often hard to determine and can only be surmised symptomatically. Unfortunately, in many teeth and gum irregularities, the teeth are treated by the dentist, when, if metabolism were more properly balanced, many of these difficulties might be remedied without resort to dentistry. More attention should be paid to the teeth of children, for tooth and gum disturbances may be symbolic of worse internal conditions.

When one scrutinizes the pages of veterinary medicine, he discovers that horse trainers and jockeys, cattle traders and animal fanciers examine the mouths of their charges to find out their general condition of health. If such an examination is found practical in the lower animals, physicians may well utilize this knowledge and place greater reliance on these signs than they have in the past. For instance, one may find, quite apart from the structural formation of the teeth, a varied amount of buccal secretion of a peculiar odor and consistency. The child's gums and mucous membranes may be swollen, with or without loss of substance, and many punctiform hemorrhages or small nodules may appear. Pustules and ulcers may be encountered. On physical examination also, many variations of stomatitis are discovered, peculiar types of tonsilitis with adenoid tissue, proclaiming a disturbed metabolism. Nutrition, then, is dependent on the ability of protoplasm to obtain materials from the blood by way of digestion, and their assimilation is essential to the nourishment and to the motivation of the various cells. Malnutrition, on the other hand, results from the failure of the cells to obtain nutrients in proper quality and quantity from this source.[4]

UNRECOGNIZED FORCES IN ORGANIC LIFE

Undeniably, theories based on faulty premises are uncertain and, in the main, cannot be depended upon. Nutritional problems are solved by clinicians from the study of scientific data obtained from reliable sources, sources which are real and not illusionary. Nature controls many partly or wholly unrecog-

ed and mysterious forces, which we recognize only symp-
atically. There surely must be some link between these
ers and organic existence. Allowing that man has more or
gained his object in the balancing up of metabolism
siologically and psychologically, at least to the extent of his
wledge, are there not in nature many unknown forces which
d to bind heredity, the soma, and metabolism into a designed
ole more completely than our materialistic theories explain?
instance, is there not something in unknown nature which
rgizes and harmonizes all the known forces which science can
nonstrate? When fortified with a good meal or with our
orite tobacco, sitting in peace and tranquility, is there not
n a great temptation to visualize the influences of these
een agencies on human economy and behaviorism? Has the
sical world of substance no objective reality apart from man's
ntal concepts of it, as Sir James Jeans would have us believe?
s true, as this scientist suggests, that photons have no indi-
ual existence, but are members of a single beam of light, the
e being true of electrons in a continuous electric current, as
be demonstrated between the millions of cells in the human
y.

Ian's mind is limited in scope and is acquainted only with
ects, experiences, and observations which fall within its
prehension. One may question whether he can ever know
essential nature of any thing, as for instance, the centimeter
a wave length or unseen mystic forces in nutrition, for they
t in that mysterious world outside his intelligence.[5]

hese mysterious forces in nature may in some way activate
The cosmic rays may serve as an illustration. These rays
bably enter the atmosphere from the outer spaces, pure
tons; that is, as light or electro-magnetic waves. They
oubtedly originate in the space between the stars where
ter is at a minimum quantity, and they must be formed in
process of building up more complicated atoms from the
ble hydrogen atoms. In this building up, the cosmic rays
uire their enormous electrical energy of, say, twenty-five
ion volts. Is is not possible that these rays, therefore, exert
enormous influence on organic life in general?

NUTRITION IN INFANCY AND CHILDHOOD

he feeding of infants would be an easy task if one could
end on tangible mathematical formulae or prescribed diets.
physics, one may restrict the extent of an electron's waves, but

one can never reduce it to a point, or indeed below a certain minimum. There is always a finite region of waves remaining which depict our knowledge precisely and exactly. In nutrition and in the treatment of diseases in infancy and childhood, hereditary forces are seen, which contribute to potentialities of health and disease, to longevity or to early death, as well as to happiness or unhappiness. Once these mysterious forces are in action, we cannot prevent them; but, fortunately, they leave signs and symptoms by which they may be regulated by means within our power of intelligence—by nutrition and environment.

With the modern conception of proper nutrition in infancy and childhood, the clinician must not only be a craftsman but a poet as well, in that he allows his imagination a certain liberty, with reservations of course. Under the most ideal conditions, no two proteins, fats, carbohydrates, etc., even though of similar nature, are alike in nutrient content, or probably in function, and the same may be said of environmental stimuli. In general, there can be no exact standardization of food nutrients nor of other necessary agencies in nutrition.

Before us lies rather a large sheaf of monographs on infant and child nutrition, all reporting cures for innumerable maladies. We fail to find any reference to heredity as the origin of certain diseases, or to the inheritance of dysfunctions as a verification of that origin. In many instances the writers, in part at least, have treated nutritional disturbances from a somatic standpoint. In the early days physicians devoted their time largely to synthetising a milk modification to suit an infant of a certain age, no attention being paid to inherited dysfunctions or to inherited states and potentialities or to environment. These methods proved successful among a few, but a failure among the many. By omitting certain nutrients, rather than decreasing them proportionally in the modifications, attempts were made to remedy the cause symptomatically. Of late, the patient, scientific work of brilliant men has made the problem of nutrition easier, but at the same time there is an unfortunate inclination to laud many nutrients unduly as a complete food rather than as one element. It is largely a waste of time and effort to try to construct a food modification comparable to mothers' milk, for into the latter enter all of the food and products, the result of a varied diet and environment. The dangerous period of artificial infant feeding lies within the first four months of life.

IS THE CHILD'S ORGANISM A MACHINE?

Has it not been a mistake in the past, to view the child's anism as a machine? Even today the comparison is often le. But let us consider the pertinent facts. First, a machine operate in only one, or at most, in a few directions, and then an unchangeable manner, in accordance with its original struction. Its individual parts cannot, under their own ver, rearrange themselves, or enter into new combinations to respond with new conditions which may confront them, as can human body. The machine cannot repair itself by utilizing products used to make it function, such as oil, petrol, water, grease. The child's organism, on the other hand, possesses an ate power of construction; for the single cell is responsive to mth, light, and food, as well as to all kinds of mechanical, siologic, and chemical influences in the multivaried expres- s of life. Mathematically, we know just how much fuel the chine will bear in a fixed standard of function, an impossibility he human organism, although mathematics have been illogi- y employed in this direction. The power of the machine, hermore, is developed in a restricted direction, but in the nan organism there exists an extraordinary force and many- d play. Consider as an illustration, the great difference ween a gramophone and the human larynx, allied with the gs, and also the nerves and muscles which set the larynx in ion.

The larynx can give rise to numerous tunes of all kinds, but instrument is able to play only the tune or tunes to which it djusted. On the other hand, without any visible changes, the nan larynx can pass from one melody to another and alter its e and rhythm by the action of the muscles which work under influence of the will. It can alter the pitch, introduce trills, s, and modifications, which an instrument cannot do. There is ther great difference, for when changes occur in the organism result of a stimulus or of stimuli, the larynx has the power, r a rest period, to return to its former condition, so that if stimulus is repeated, the larynx will perform the same action in. The machine, on the contrary, has no power to repair injuries or wear and tear. It cannot lubricate itself, clean lf, or renew its function. There is still another difference. mechanical machine can create a new machine nor has any hanic yet succeeded in constructing anything which, by sion, will shape itself into two instruments where but one ted before. With such a machine, the movements of the

rollers, wheels, levers, and other parts can readily be explained on purely mechanical principles, but in the human organism a chemical operation cannot be explained mechanically. And lastly, while the movements of the various parts of the machine are firmly united to one another through their construction, so that they can not alter themselves independently, the living organism is able to alter its structure and at the same time set aside by-products without in any way interfering with its own existence or work. One can not too strongly oppose, therefore, such wanton expressions as, "The child's body is but a Machine," and, "Given equal weight and age, all infants and children can be nourished alike." These conclusions are unwise, illogical, unbiologic, and unscientific.[6]

The fundamental characteristics of the machine are essentially of a physical and chemical nature, and the properties of steel and brass, oil and water, electricity and magnetism, lead and acid, and of copper wires and insulating tape may all be considered to be of this nature. As machines are built in individual units and physically bound together, a worn or broken part may be readily replaced and the life of the machine prolonged. The automobile manufacturer establishes a speed limit for his product beyond which it cannot travel. The duration of the automobile's life is rated in terms of mileage. The child's body, on the other hand, is no machine, nor can it be treated as such or compared to one, for it must be built up from organs or parts of organs already biologically in place. A complex electrical installation, as ingenious and intricate as workmanship can make it, is not comparable to the human body, for the vast number of organs and tissues of the organism possess even greater interdependence. Adaptability and coordination are properties inherent in the human mind, but absent in the machine. The functions of the central nervous system far outnumber those performed by electric wiring. Just as the construction and maintenance of a motor car require a greater knowledge than the mere act of driving, so does the building up of human organs and the development of their proper functions necessitate more thought and study than do the average problems of human existence. The prolongation of life cannot be considered from any one angle alone, for it is a mass effort of all nature's biologic forces.[7]

INHERITED TYPES CONCERNED IN NUTRITION

The recognition of hereditary and somatic disease potentialities and dysfunctions in their incipiency, in contrast to what

nstitutes health, is a running start on the science of proper itrition. Inherited types of body build, with their peculiar, dividualistic, and characteristic tendencies, tend to induce parate and distinct metabolism rates, and are unable to con- rm to any standardization of nutrition. Physicians recognize nong the new born, three main types.

The first is the infant with hard compact musculature, with an parent tendency to strong and sturdy bones and framework, ssessing, as far as one can judge, good internal organs and sues. Our impression is that this child undergoes changes in er years to rather large hands and feet, to strong musculature, th bones which are often thick and short; a type which usually s a well-balanced nervous system. The second type is poorly veloped, malnourished, having a flabby musculature with lexes often retarded, in whom one also finds present a sebor- oeic eczema of the scalp, a pale, greasy skin, clammy sweat in e arm pits and on the posterior surface of the knee joint, as ll as a narrow chest, a soft, often protuberant abdomen, but th little subcutaneous fat. Such infants, suffering from faulty trition and environment, develop later into weak, emotional, le, puny, and whining individuals, and seem to have a strong tentiality to disease.

One may, incidentally, mention a third type, one of gross ierited dysfunction, as seen in cretins, achondroplasiacs, etc. iese infants are usually thickset and short necked, with short s and arms, and with an abnormally shaped cranium, and they ssess a predisposition to add fat to the trunk, arms, and legs. iey are strongly predestined to disease. Obviously one may d abnormal psychologic states in the new born which, as the ain grows to maturity, become dominant in character. Some these are feeble-mindedness and similar psychopathic mental nditions, and there is a corresponding physical weakness.[8]

The study of inherited characteristics, such as body stature as it ates to nutrition, should be better understood. It is unbio- gical to try to reduce a child's weight if that child has inherited otentiality for an increase in body fat. It is equally wrong to leavor to add weight when the inheritance pattern calls for no h addition. Strouse maintains that few over-eat to the point harm. If he means quantity, that statement may be true, but cannot mean quality or the kind of nutrient. He states further- ore that, "we cannot consider seriously the harm of protein," l probably refers to animal protein, as an acid food in the ology of fevers, arthritis, hypertension, nephritis, and other eases. In regard to the total requirement of calories in the

child's body he says, "In the amount of protein, fat, and carbohydrate ingested, nature has a peculiar way of protecting her children so that they manage to eat about what they need to live on." Many do not agree with him. The customs of fasting after food and drink excesses flourished among the Romans and other people. They resorted to this method to relieve their bodies from an overstrain. With modern scientific methods this practice is unwise and entirely unnecessary.[9]

Food panaceas and fads are usually transitory, and have no lasting scientific basis. The Arabs fondly hoped that they had found a panacea for mental and physical ailments in their discovery of alcohol. But they were soon to learn that alcohol in excess was extremely dangerous.

The most careful selection and modification of food has its limitations and none will exactly correspond to mother's milk; and such modifications must be made to suit the minor or intermediate dysfunctions and potentialities of the child rather than that the child be forced to accept them. On properly constructed diets many infants are able to walk at nine months.[10]

NORMALITY AND ABNORMALITY

The term *normality* is an elastic one and is variously interpreted by the anthropologist, the morphologist, the physiologist, and even the moralist. Possibly we, as physicians, regard those children as normal whose responses correspond completely to those biologic needs which depend upon the child's physical, chemical, psychic, and social environment; while abnormality constitutes an incongruity between vital responses and individual needs for biologic performances. One may employ, in this case, Grote's phraseology of responsiveness and irresponsiveness, concerning those whose reactions correspond or do not correspond to their individual biologic needs.[11]

THE RELATIONSHIP BETWEEN THE INTERIOR AND EXTERIOR OF THE CHILD'S BODY

Were physicians gifted with microscopic vision and ocular x-ray penetration, they might be able to view the interior body and to discover the age, size, structure, and functional capabilities of the many organs and tissues. They could visually ascertain harmony or disharmony between these structures and the exterior body, as they have previously done symptomatically. With this knowledge nutritional problems would be simplified.

The skeletal body of the normal child grows quickly around the ge of puberty, and the internal organs, with their various nctions, do not keep pace with it, even when these organs emand more and more food through hunger urge. Often in a ockily built child of a particular race, or even in one of dwarfed ature, the internal organs, including the brain, may show a pid development. Coincident with a sound body, there may be ental precocity which is pleasing to both parent and teacher. an early age the child often stands at the head of his class, but ter in life may find himself at the foot.

The opposite picture is that of a long, lanky, slender child hose skeleton grows more rapidly than his internal organs, who ver seems to get enough to eat, is backward in school, plays uant, who is often shy and self-effacing, and is often looked oon as a backward pupil. At maturity, with the cessation of dy growth and its demands on the internal organs, with the ain beginning to develop under proper nutrition and environ-ental stimuli, the picture changes. Those shy, diffident boys d girls now become potentialities for greatness in all walks of e.

ALONG THE WAY

Many minor types of inherited dysfunctions are of surprisingly equent occurrence, but being unrecognized they are often over-oked nutritionally. There may be found a moderate hypo- or perfunction of the gastric secretion and slightly increased or creased stomach motility. Often children who in early life re unable to ingest milk without belching, pain, or diarrhoea, n digest it readily in after years. With minor or subminor nditions, existing nutrition and environment being suitable, e more and the stronger food the infant is able to digest and etabolize, the quicker will these dysfunctions disappear. In ese children, in whom there is usually present a lesser amount hydrochloric acid, a longer time is required for the completion gastric digestion, but the longer the digestive process, other ngs being equal, the better can metabolism be balanced and e more rapidly can growth and development take place. If wever, an infant inherited a heightened growth impulse; for ample, if its stomach functions at a level higher than that of other infant, this child can not only digest and metabolize ore and richer food, but the feeding periods should be length-ed to better handle these larger amounts of food, when growth d development will follow normal paths.

There is a close parallel, it seems to us, between the time when the stomach is being emptied of food and the appearance of the gastric hunger contractions. The frequent calls for food are undoubtedly caused by the fact that the stomach contractions appear at shorter intervals than in other children.

The treatment of these conditions has often baffled physicians and they have resorted to emergency feedings with poor results. In children suffering from gastric hypersecretion, particularly that of hydrochloric acid, and with hypermotility, cream cheese in the diet usually soaks up the excess secretion, and olive oil given with feedings prolongs the emptying time of the stomach, thus retaining the ingested food in that organ until gastric digestion has taken place. Incidentally, we have usually tried to bring the gastric contractions and the child's appetite urge more into conjunction.[12]

PROTEINS IN NUTRITION

The animal proteins found in milk tend to enhance the value of contributory vegetable proteins in the balancing of nutrition, for these proteins of good quality will induce normal growth when fed probably at about the ratio of nine percent intake of the food mixture. In order to insure health, both animal and vegetable proteins used in infant feeding must be of excellent quality. Proteins and other foods differ in their individual nutrient content both in quality and quantity. Even the biologic value of the proteins of animal tissues varies greatly for growth and maintenance of health. Vegetable proteins likewise differ, as seen, for instance, in samples of wheat. Every housewife knows that the dough-forming propensities vary markedly in different wheats. These qualities depend on the peculiar nature of the proteins of the grain, and may be due to a lack of uniformity in the relative amounts of the individual proteins contained in the seed. In infant food modifications and in the diet of the older child, it is wise not only to vary the cereal but to obtain such cereals in packages and from agricultural areas situated at points well apart, to insure a sufficient nutrient average.[13]

MINERAL DEFICIENCIES IN NUTRITION

The responsibilities confronting the pediatrician in the first six months of an infant's life are many and varied. The problem of artificial feeding with the selection of digestible and metabolizable food stuffs to insure growth and development as well as to

tect the infant from disease, including secondary anaemia, s for genius, experience, observations, and research. So im-tant do we consider balanced nutrition in nutritional anemias, t we have given the subject space and attention elsewhere in se chapters. The lack of any suitable nutrient in metabolism rferes with the delicate cell adjustments. A marked deficiency he mineral salts in infant feeding is a fitting illustration. If grant that the mineral salts activate metabolism, is it not bable that the activities of the biologic cell in its intake of ls and in its discharge of metabolized products would, there-, be greatly interfered with in case of a mineral deficiency? heresy, then, to believe that certain types of malnutrition, secondary anemias of early infancy, the varied minor patho-cal reactions of the skin and internal organs, and many r somatic dysfunctions may often arise not only from a ciency of the salt and iron in milk but from a similar lack ther balancing mineral salts as well.

laboratory experiment by Daniels and Hutton bears upon point. These experimenters added cereal dilutents, wheat ryo extract, lactose, beef extract, cornstarch, cod liver oil, n, and various calcium salts to the milk feeding of white rats. hey found that without the additional mineral salts, the itive value of this milk was not improved. Some rats un-ably thrived upon it, but the majority did not. Similar itions occur from inadequate nutrition in infancy. These little white rats were later fed a thick starch paste contain-mixture of aluminum, potassium sulphate, sodium fluoride, im salycilate, and manganese sulphate, in arbitrary amounts. these salts were added to the milk, the mixture was brought e boiling point, when one drop of a two percent solution of im iodiate and three drops of a saturated solution of iron added to each 200 c.c. of the mixture. On this ration the vere found to have developed well. They were vigorous and reproductive power was high. Many investigators have rted unsatisfactory growth in animals on diets of milk alone, nutrient deficiencies in milk modifications in early infancy been the cause of much of the malnutrition found. It d seem that in many instances when cow's milk is used in cial feeding there is a deficiency of certain essential ele-s, owing to a faulty metabolism in the cow, possibly through eprivation of essential mineral salts in her food. In con-nce of this deficiency, chemical interactions in the food-iple combinations of the cell render certain of the salts nt inert. In our clinical work in the artificial nutrition of

infants, we have used vegetable waters rather than pure water in milk modifications, and have found results very satisfactory. Pure water contains no food nutrients, at least not in large amounts, while vegetable waters possess vitamins and many mineral salts.[14]

Owing to the scarcity of these salts in cereals, legume seeds, tubers, and in fleshy roots, a condition which occurs particularly in drought-stricken areas, many older children do not obtain in their diets sufficient amounts of these minerals. Even under normal conditions, they may not be found in sufficient quantity to supply children with enough fat-soluble vitamin A alone.

Wrongly or rightly, we have felt that the mineral salt requirement of an infant or child, particularly that of the calcium and phosphorus salts, might be clinically calculated from the condition of the teeth and gums. It is true that the structure and rudiments of the teeth and gums may be referred to heredity, but as the storage of these salts in the child's body from the mother's placenta usually becomes exhausted soon after birth, the structure of the teeth may be changed and their rudiments damaged. An underweight infant may have the same calcium, phosphorus, or other salt needs as the normal infant of the same age, but is constantly being deprived of these mineral elements. Clinical calculations as to the amounts of mineral salts necessary for a given child are arbitrary and usually inadequate, for the optimum amount of calcium and phosphorus retention, as well as that for other salts, is quite unknown, on account of the great influence of hereditary and environmental factors.

Czerny and Keller, in a report made on certain breast-fed infants on the basis of their theoretical weights, showed that they retained an average of 0.027 grams of calcium oxide per kilo, whereas those infants artificially fed retained an average of 0.031 grams per kilo.[15]

IRON AND ANEMIA

Many clinicians have written extensively on iron in secondary anemias and have felt that the low content of mineral salts, particularly iron in cow's milk, has contributed to their occurrence. The healthy mother contributes to her new born infant certain inorganic salts and other nutrient storage, if her own metabolism is well balanced. The nursing mother, to resupply that storage, must adjust her diet and environment to the needs of the growing child. Bunge and Abderhalden have showed that

e ash of the milk of the mother and that of the new born imal of the same species are essentially similar in all constitnts except iron, which is six times as abundant in the ash of e young animal as in the ash of the milk on which this animal s nourished. Nature, therefore, seems to supply the young imal at birth with a reserve store of iron, but often this storage depleted before particular foods rich in iron supplement that ntained in the nursing milk. Such a depletion occurs usually thin the first four months after birth. Some scientists claim have been able to increase the percentage of iron in the milk feeding the cows various compounds of iron, while others ve arrived at opposite conclusions. Hess, Unger, and Supples ve reported that milk from cows in pasture under natural nditions of feed, sunlight, and water supply, contained twice amount of iron, in contrast to cows fed on corn meal and on ular winter rations. In later experiments, however, they conded that the iron content of goat's milk in particular could be increased by feeding the goats ferric-oxide or the very uble salt, ferrous sulphate water. Indeed, no noticeable change ld be detected in the iron content, even when this addition of n was increased five-fold above the original content. Identical coveries were made when alfalfa hay and timothy hay were d, but the alfalfa hay contained twice as much iron as did the othy. It would seem therefore, that the artificially fed child, st of necessity, obtain more iron from the milk of cows under ural rather than under artificial conditions.[16]

THE FORM OF IRON BEST UTILIZED

The time-worn question as to what form of iron is best for oglobin synthesis in the human organism remains unvered, despite the fact that many pediatricians still add an compound to milk modifications. Inorganic and medicinal remedies, we believe, are ineffective in many cases of anemia, they are merely stimulative, and not constructive. Many sicians, on the contrary, believe that these medicines parpate in hemoglobin building. It would seem that, with the olishment of a perfected metabolism balance, the necessary content of the blood would take care of itself. Hopeful rvers, such as Barkan, Baumgarten, and Seyderhelm, have nted beneficial results from the use of large quantities of ganic iron, but they disagree as to the exact function of this eral in the body.[17]

EXCLUSIVE MILK DIETS

The most difficult period, nutritionally, for infants, lies within the first six months of life. Milk is the most completely balanced food known, qualitatively. In amounts of the several nutrients it is far too low for adequate growth and maintenance in human beings. In infant modifications, when water is added, there is a further reduction in nutrient quantity and the water adds no additional nourishment, being only a solvent. Milk modifications, in the past, have, therefore, often been inadequate, incomplete, and unsustaining, and many times, they have been but feeble attempts to simulate natural milk. With the older child, an exclusive milk diet over a short period may be of benefit, for it has presumedly previously stored within its organism enough nutrients to tide it over a malnutritional interim. Over a long period, however, such a diet is quite unbiologic. In many gastro-enteric disturbances, milk is a great modifier of the intestinal flora. Pettger, Cheflin, Cannon, and McNease have shown that milk changes the intestinal flora of young rats from a predominant bacillus coli type to a predominant bacillus acidophilus. These men found milk beneficial in the treatment of dysentery, and in intestinal protozoan infections.

In a series of experiments made similarly on monkeys and on children, preliminary fecal examinations were made six or more days prior to starting the milk diet. Two children were found to be positive for amoebic disturbances. It is of interest to note that important conclusions were drawn from the results of three experiments.

In the first experiment, boiled milk was fed to monkeys for two weeks and although the amoebae disappeared for a time they reappeared two weeks later. In the second experiment, unboiled milk was fed to those animals for two weeks also. Their health, on the whole, appeared to be better than those on the first diet, since sixty percent became permanently negative for E Dysenteriae, one hundred percent for E-doli; forty percent for Endolimax, and eighty percent for Sod-amoeba. The third experiment proves the most interesting, for it concerns human beings. Unboiled milk was fed exclusively to children for ten days. Three of the group were strongly positive for amoebae. As the children fought against the diet and were losing weight, it was discontinued. Even in this short period, however, a marked decrease in the amoebae was noticed, and one child showed a decided and permanent cure. In many cases, the intestinal tract was cleared

E-Dysenteriae and of other forms, and remained clear of em for long periods. Milk is however only one of nature's any food remedies which eliminate pathologic conditions in e body.[18]

An exclusive milk diet, extended over a long period, and in ite of the elimination of possible intestinal pathologic organns, is a hazardous undertaking. Unsupported by other foods or od nutrients to balance the metabolism, an exclusive whole lk regimen may cause nutritional anemias in older children. hile in early infancy the treatment of nutritional anemia rests gely on the inorganic salts, the same condition in older ldren must be thwarted by other and more extensive methods. the anemias of older children, it is often observed, especially ere severe malnutrition is present, that the stools are hard, npy, and light colored. In those instances liver meal is a uable asset to a regulatory diet. In later infancy also, where stools are clay colored, lumpy, resembling cheese, this liver al may prove of benefit. Waddell and his co-workers subted rabbits to a whole milk ration and found conditions ilar to those present in the children, but discovered they ld be corrected by the additions of the ash of lettuce or bage, whole lettuce or chipped cabbage being used in children identical purposes. These experimentors subsequently disered that dried liver and dried spleen marrow were potent if at a level of two grams per animal daily, as a supplement to hole milk diet. It was also discovered that the daily adminution of the ash of two grams of dried bone marrow delayed onset of anemia, but that this amount was considered ficient over a long period of time. Still further experiments e undertaken with rats suffering from nutritional anemia ough iron salt-deficiency; the ash of beef liver proved corrective preventative. Ferric chloride was fed at a level of 0.5 millins of iron per animal, but the anemia was not corrected. en the little animals were given beef liver or its ash, the dition was changed for the better. Sometimes this finely erized dried liver powder was given in the milk ration. These stigators fed from one to seventy-two grams of liver powder to in 0.5 milligrams of the iron contained in it. Their results ved that in these forms of anemia the iron contained in the ash was extremely potent in restoring to normal the noglobin content of the blood.[19]

nally, the diets of children in general are often overcharged meat and eggs, to the exclusion of other nutrients necessary ne balancing of metabolism. One may gain valuable infor-

mation in this respect from a little experiment on cats maintained on a meat and milk diet; in fact, quite the ordinary food for these animals. These cats all reacted differently to this diet. In general, the urine, instead of being acid, was found to be intensely alkaline in character, and possessed strong reducing properties. Its odor was very disagreeable. Intermittent diarrhoeas occurred. When water was substituted for the milk, however, the urine became acid, but the same symptoms recurred when the milk was again substituted for water. The cats excreted huge amounts of the bicarbonates and there was an increase in ammonia elimination. After forty-eight hours, and with the withdrawal of the milk, conditions returned to normal. The milk sugar of the milk ration was not considered responsible for these disturbances.[20]

THREE PRODUCTS OF NUTRITION
THE BLOOD

The blood contains all the elements essential for the maintenance of life. It may also carry toxic substances, products resulting from dysfunction, from micro-organisms, from drugs, from faulty foods. It contains, also, the secretions of the ductless, sexual, and of other glands—bodies which affect growth and development. The blood flows into and out of the brain and to and from the body organs with a certain velocity, and under a definite pressure.[21] Just as long as these conditions are maintained in a strictly physiologic manner, just so long will the cells of the brain and body respond to environmental stimuli. There is no doubt that in some way this blood flow through the body is regulated in accordance with the requirements of each organ so that during extra activity in any part there is a greater blood in-flow. This fluid, as has been said, conveys food materials from the digestive organs and oxygen from the lungs to the organs and tissues, and it receives from these organs and tissues the various substances which are, in turn, carried to other tissues or to secretory organs. From these latter sources, it receives carbon dioxide and the products of nitrogenous metabolism. It is evident that its composition must vary from time to time, from place to place, according to the number of nutrients and toxins contained within it, and according to its activity, as well as that of the organ which it is traversing. The organs of the child's body, through their cells, are adjusted to respond to very minute changes in the composition of this circulating fluid, and add to or subtract from

e constituents of the blood as they are found to be present in ficient or in excessive amounts.

The heart, of course, pumps the blood to various organs and sues. When its nutrient fluid is properly aerated to insure enty of oxygen, it contracts with a strong rhythm. This rhythm, wever, responds quickly to changes in the composition of the ood and it is quite probable that inorganic salts affect the aracter and development of the cardiac rhythm. The blood, oreover, is to be regarded as a reservoir of nutritive materials a condition to be absorbed and transformed into utilizable d living material. Inasmuch as the materials which are lost in body daily through processes of disintegration and oxidation supplied by the blood, it is evident that this fluid would ninish rapidly in volume with a corresponding decline in ctional activity, were it not replenished by the introduction o the body of the new materials (nutrients) in the food.

This re-supply is brought about directly through the sensations hunger and thirst, and indirectly through biologic fatigue, aids healthy childhood. In order to enable the organs and tissues the child's body, through their basic cells, to continue to form functions, it is essential that these cells be supplied with ritive materials similar to those which enter into their own nposition; namely, proteins, fats, carbohydrates, inorganic s, and water. These compounds, though originally derived n the food, are immediately received by the cells from the od as it flows through the capillaries.[21]

The blood stream may be said to be electrically charged ough its red blood corpuscles, the erythrocytes. Indeed, many s point to the fact that the red blood corpuscles are small densors of static electricity.[22] It can easily be seen that any nges, extrinsic or intrinsic, the presence or absence of neces- psychic and physical stimuli, of needed food principles, etc., affect the blood stream most profoundly. For example, ider the effects of prolonged fasting, a common condition ng the world depression. The potentialities of a continuous -stocked food stream can never be overestimated; a deficient food-storage leads to maldevelopment, even to decay. We read of the fearful malnutrition and distress seen in Euro- children following the World War. By experiments on dogs, may well visualize just what this prolonged under-nutrition done. Marqulis and Edwards discovered in their work on ng dogs, that the non-protein and urea nitrogen of the blood eased during the early stages of inanition and then remained

at an almost fixed level until the extreme stage was reached, when a new and much greater increase in nitrogen occurred. The amino-acid nitrogen either remained constant throughout the duration of the fast or it diminished slightly, but it rose once more during the latter part of the fast. The blood uric acid increased progressively during inanition. The creatinin remained constant, but the creatin, following a diminution which may have occurred at an early stage of the fast, rose rapidly in the ultimate stage. The blood sugar and the chlorides which usually diminish in the course of the first half of the fasting period increased again during the later stages of this inanition. At the time when the body weight of the dogs had decreased forty percent or more, the blood sugar level exceeded the normal, with but one exception; the undetermined nitrogen, and the percentage of total solids in the blood of these dogs increased during this fasting period. The same effects were noted when the dogs received no water as when they did, but in the former case these changes occurred more quickly. Upon refeeding, it was noticed that the non-protein and urea nitrogen, the uric acid, and the creatin decreased rapidly in those first few days of food replenishment. This was particularly striking in the non-protein and the urea nitrogen moieties. When these refed animals had regained thirty-five to forty-five percent in weight, the urea and the total non-protein nitrogen began to increase again, tending to return to their original level. The amino-acid nitrogen underwent slight changes, while the creatinin content of the blood was entirely unaffected by the refeeding. In general, it may be said that the composition of the blood approached the normal. Since the biologic cells are so dependent on the blood, and the blood in turn, bases its nutritive properties on metabolism, a fuller study of the intricate and delicate mechanism of this wonderful natural laboratory would be very profitable.[23]

THE URINE

No diagnosis should be considered complete and no form of treatment should be instituted without a macroscopic, chemical and microscopic examination of the urine. The specific gravity, the color, odor, and the consistency may be observed macroscopically. Chemical tests are made for the acid or alkaline reaction, for albumin, sugar, acetone, diacetic acid, indican, bile, urea, uric acid, and for the total nitrogen, etc. Microscopically, casts are brought to light, as well as crystals, pus, bacteria, epithelium, stray red blood cells and other irregular bodies.

The study of the composition of the urine is of great impor-nce, for it stresses the fact that its content is intimately related metabolism. For example, acid urine is due to the presence of e acid salts of sulphuric and phosphoric acids and of other id radicles. These acid salts are derived from the sulphur of oteins and from the phosphorus of lecithin. The acidity is, erefore, largely related to the presence of animal proteins in e diet; chiefly meat and eggs. In a diet consisting mainly of getables and fruits the urine may become alkaline in reaction, ing to the preponderance of the alkaline bases. The fruit ds, such as the tartaric, citric, and malic, combine with bases form alkaline carbonates. These carbonates pass into the ine and either diminish its acidity or render it alkaline, a very portant point to remember in the treatment of many types of isitizations.

In children, the quantity of urine eliminated daily varies from 00 and 1700 cc. This quantity is influenced by many factors, wever, including those which affect the water content of the ues and the emotional states aroused by environmental stimuli, h physical and psychic. The ingestion of large quantities of ter or other fluids, or a diminution in the activity of the skin accompanied by an increased excretion of urine. On the er hand, a small intake of water or other fluids, plus an essive perspiration, or diarrhoea, diminish the amount. The ater portion of the urine of the child is excreted during the , due probably to muscular activity and to a more active blood culation during the waking hours. Owing to the immaturity the child's organs, the composition of the urine varies from e to time, in accordance with the nature of the food eaten and h the metabolism of the tissues.

The table shows the average composition of urine of children:

HEMICAL COMPOSITION OF URINE ACCORDING TO HACHMANN

er	1500.00 cc.
l Solids	72.00 grams
Urea	33.18 "
Uric acid (urates)	0.55 "
Hippuric acid (hippurates)	0.40 "
Creatinin, xanthin, hypoxanthin, guanin, ammonium salts, pigments, etc.	11.21 "
Inorganic salts; sodium and potassium sulphates, phosphates and chlorides; magnesium and calcium phosphates	27.00 "

Organic salts, such as lactates, acetates, and formates, are found in small amounts. Nitrogen and carbon dioxide are also present at times. As the urine contains nearly all the end products of protein metabolism, its analysis in a given case is extremely important, as, for example, in cases of rheumatic diatheses, food sensitizations, eczemas, urethritis, gastro-intestinal intoxications and fermentation, gastritis, constipation, catarrhal jaundice, headaches, lowered immunity, and a host of other irregularities due to disordered metabolism.

A forewarning of many of these dysfunctions may be gained from the presence in the urine of urea and uric acid. An understanding of the formation of these two bodies is necessary to the study of many somatic diseases, particularly those of a nutritional character; which are the result of an excess of animal foods in the diet. During the digestion the nucleo-proteins of both animal and vegetable origin which form the chief constituents of the cell nuclei are split into a number of complex bodies which ultimately yield uric acid. In prescribing diets for children, it is well to remember that stimulants such as coffee, tea, and even cocoa are sources of uric acid, owing to the presence of caffeine, theophylline, and theobromine, respectively. This type of uric acid formation is called exogenous, and any food containing large amounts of nucleic acid, such as liver, sweetbreads, and kidneys, will give rise to uric acid.

The formation of urea presents a much more difficult problem. As has been explained, the proteins of the food are absorbed into the blood in the form of amino-acids, of which only those normally present in the body can be utilized for repair and for the growth of the tissues. An excess of these amino-acids, as well as other foreign amino-acids, undergoes a process of cleavage. Further, the amine radicle combines with hydrogen and carbon dioxide to form ammonium carbonate and ammonium carbamate, which are then transformed in the liver into urea by a process of dehydration. The ingestion of relatively large amounts of protein and of sugar, particularly lactose, raises the osmotic tension of the blood, causing a flow of water from the tissues into the blood vessels, the result being the same as from the drinking of large quantities of water.

Consider for the moment the natural process of diuresia. Our morning coffee furnishes us with caffeine, an active diuretic, an effect which is undoubtedly due to an alteration in the permeability of the glomeruler capsule of the kidney permitting more rapid filtration through it. The rapid flow of this fluid through the tubule reduces reabsorption so that more of the glomerular

ltrate reaches the ureter than usual. Asparagus acts as an irri-ating and stimulating diuretic; our before-dinner cocktail is an-ther. Also water, the salts, sugar, and many metabolic end-roducts have this characteristic. All diuretics function in four ays:—first, by lessening the viscidity of the blood, thereby in-reasing its filtrability and raising the glomeruler pressure; sec-nd, by shrinking the kidney cells; third, by decreasing or pre-enting tubular absorption; and fourth, by stimulating slightly ne activity of the kidney cells. For years physicians have advo-ated the drinking of water, particularly between meals. Drink-g water is a hypotonic solution and is practically unabsorbed the stomach. It does, however, abstract salts from the mucus, om the food, and from the superficial cells of the alimentary nal, or else it takes up the sodium chloride formed by the eutralization of the hydrochloric acid of the gastric juice in e duodenum. In this way the water becomes a saline solution, absorbed instead of passing on into the rectum. Water in rge quantities is diuretic in its action, and by its elimination sists in the removal of certain soluble substances, particularly ea, the sulphates, and phosphates.[24]

It is well to bear in mind, however, that in giving the child ater to quench its thirst more fluid may be taken into the body an the organism requires. Every child, ill or well, ingests natu-lly just as much fluid as the body needs, depending upon the nount of exercise, upon the time of the year, upon the proper improper functioning of his organs, upon the temperature of e body, upon the type of food, its dryness or moistness, its lted or unsalted condition, as well as upon other factors. The rcing of water-drinking, as has been advocated, causes a sense fullness, a loss of energy, a disinclination to play or to any ertion.

The ingestion of large amounts of water also causes a signifi-nt dilution of the blood and of the serum proteins. The salt ntent is reduced, the chlorides and sodium salts being de-eased to a much greater extent than might be expected from e degree of dilution. Large quantities of water passing through e body of the child may rob it of much of its salt content, in-ed, to such an extent that a resultant upset of the water-salt uilibrium may occur, with a consequent change in the ionic ncentration of the biologic cell. This body flooding may cause marked and constant increase in the excretion of the chlorides, osphates, ammonia, creatinin, and the total acid content.[25] rbonated waters, lemonades, orangeades, and limeades, and fusions such as the catnip tea of our boyhood are very palatable,

and because of the presence of added substances they enhance the diuretic action of the water. Milk is another diuretic the action of which depends largely on its water content and only partly on its sugar or lactose. The inorganic salts, products which exert from first to last such an enormous influence on the growth, repair, and development of the child's body, are all diuretic in their action. Under this characterization may be listed sodium bicarbonate, the sodium and potassium iodides, and the nitrates. Organic salts, such as sodium, potassium citrates, and the acetates, which are oxidized to bicarbonates within the body, are very effective and are in common use, for they are found in a great variety of foods.

The therapeutic use of diuretics in disease includes the removal of liquid from the body, a necessity seen rarely in infancy and but little more in childhood, the elimination of toxins of metabolic or bacterial origin, and the dilution of the urine to lessen irritation in the urinary passages, or to dilute the irritating poisons which are eliminated in the urine, or again, to prevent the formation of urinary calculi. If in metabolic disturbances the necessity arises for inducing profuse sweating, we may turn to the simple methods of raising and maintaining body heat; by exercise, by the addition of extra bed clothing, by the administration of hot drinks, or by hot baths, vapor baths, hot water bottles, etc. Water is indeed an effective diaphoretic and especially so if taken in the form of hot lemonade or orangeade, etc. Cold water is primarily diuretic in action, but if it is taken in large quantities and combined with such measures as exercise or hot baths, an excessive diaphoresis results.

Diaphoresis is the result of both reflex and direct stimulation to the sweat centers and is employed therapeutically in rare cases to remove fluid from the body, as in edema and dropsy, but more often to overcome chill and cold by reestablishing normal cutaneous circulation, thereby relieving internal congestion and assisting the kidneys in the removal of toxins by promoting their elimination in the sweat secretion.[24]

Intestinal bacteria act upon the propionic acid radicle of tryptophan and convert it into skatol and indol. These latter, together with phenol, C_6H_5—OH, and p-cresol, $CH_3C_6H_4OH$, the products of the bacterial putrefaction of phenylalanin and tyrosin, and the poisons skatol and indol, are conjugated with sulphuric acid in the liver and are eliminated as etheral sulphates in the urine.

The urine removes soluble products of metabolism from the child's organism and the respiration eliminates the gaseous

roducts. The combined mechanisms maintain the normal re-ction of the blood. In general, the organic constituents of the rine may be said to comprise compounds which contain nitro-en. Formic acid (H.COOH) is considerably increased in the ody after carbohydrate and fat administration and to a lesser xtent after protein ingestion; possibly, as Dakin suggests, all nese three foodstuffs yield formic acid as an end-product of neir metabolism. It is, however, readily oxidizable and is elimi-ated in only small amounts in the urine. Creatinin and creatin re two other excretory products. The influence of both high nd low protein diets on the relative amounts of the nitrogenous onstituents of the urine can be observed in the following nart:—

INFLUENCE OF HIGH AND LOW PROTEIN DIETS ON THE RELATIVE AMOUNTS OF THE NITROGENOUS CONSTITUENTS OF URINE ACCORDING TO LUSK

Food				Composition of the Urine in Grams				
	In Grams	In Calories	Total	Urea	Ammonia N	Uric Acid N	Creatinin N	Undetermined N
otein........ t............ rbohydrate..	118–19N 148 225	2786	16.8	14.70 87.5%	0.49 3.0%	0.18 1.1%	0.58 3.6%	0.85 4.9%
otein........ t............ rbohydrate..	6–1 N 52 400	2153	3.6	2.20 61.7%	0.42 11.3%	0.09 2.5%	0.60 17.2%	0.27 7.3%

Thus the difference between a diet containing a medium nount of protein and one almost free from protein is due to e difference in the output of urea.

The quantity of ammonia in the urine represents the alkali ntent of the body. The child's reserves of alkali are consid-able and replenishment is brought about by the alkalis which e contained in the daily foods. Hasselbalch, according to Lusk, nducted a series of experiments which showed that when an id urine was being secreted the carbon dioxide (CO_2) tension the areolar air was lowered, indicating increased acid in the ood. A diet, however, which produced a less acid, or an alka-ne urine, increased the carbon dioxide (CO_2) tension of the eolar air and indicated a larger content of alkali in the blood.

Moreover, if acid is administered to such an extent that the reaction of the blood becomes acid, death results. On the other hand, if acid is given with food in moderate quantity, an increased ammonia production from these foods may neutralize the acid ingested. In food intoxications in infants and children, there is found to be an increased production of ammonia in the kidney for the neutralization of the acids of endogenous origin. A reduction in the carbon dioxide combining power of the blood indicates a reduction in the alkali reserve, which tends toward acidosis. Klein and Moritz found that a diet rich in fat caused an increase in the quantity of fixed alkali in the urine and also a fall in the ammonia content. They found, too, that the number of grams of ammonia eliminated in the urine in twenty-four hours was an indicator of the intensity of acid formation within the body.[26]

THE FECES

The feces represent the physiologic waste products remaining after digestion has been completed. Physicians of an older school based many of their diagnoses of gastro-intestinal disturbances on the appearance and odor of this eliminated mass, rather than on the findings of the diagnostic laboratories, which were at that time in their infancy. The intestinal canal in which the feces are formed is a long tube, open at both ends, through which passes the nitrogen of the air which is swallowed with both the digestible and indigestible substances in ingested food. A correct examination of the stools of children is even more difficult than that of their urine, and collection of the feces, particularly of infants, is often unsatisfactory, as the movements tend to mix with the escaping urine. In older children the urine may be collected frequently. The urine may be said to represent the food taken into the body, as well as the course of protein metabolism at that time. The feces, on the other hand, are passed less often, and some of the food residue is not evacuated except at long intervals. Even when a large amount of meat is eaten at a meal, it is probable that the number of protein substances found in an examination of the residue is not quite proportional to the amount of meat eaten.

Fritz Voit believes that the feces are derived principally from the substances which are excreted through the wall of the intestine. Hill and Bloor have shown that the fat of the feces is not the fat of the ingested food, for the chemical composition of the feces fat is quite different.

It has been established also, that in the dog the feeding of mple foodstuffs, such as meat, fat, and sugar, scarcely influnces the composition of the feces. Prausnitz placed a man on a ce diet and then substituted meat for the rice. He found that e composition of the feces did not vary with the changes, but as of a type that might be considered normal. A large part the great amount of cellulose eaten by herbivorous animals is iminated undigested, and, after long retention, the remainder eventually passed in the evacuations. In children, following ordinary meal, there may be as much nitrogen in the feces as the urine. In certain intestinal diseases incident to childhood, e quantity of fecal nitrogen is largely increased. The evacuaons of normal children result from the complete digestion of most any ingested food. Prausnitz finds no basic differences in gestibility and absorbability between animal and vegetable ods. However, in clinical practice, we like to believe that this true only in part. The feces of a normal, healthy child tend indicate whether the given food is a small or large builder of od waste, and not how much or how little food has been ilized in the organism. Many parents point with joy to the ge fecal masses passed by their children, while other parents e unduly worried over small evacuations. Forget for the moent the food value of such vegetables as cabbage, string beans, uliflower, and the like; disregard their flavor and vitamin conit, but consider their importance as activators of peristalsis rough their indigestible waste products. Mendel has pointed t that such edible carbohydrate substances as Iceland moss d agar agar, while acting as good laxatives, are of but little portance in nutrition. Even the proteins found in mushrooms e not completely digested in the body and should not be inded in a child's diet.

Though the quantities of bacteria may have some importance the stools of children suffering from certain disease, we believe it, on the whole, they are insignificant when compared to amounts of food usually ingested, and that a balancing of tabolism may result in more good than any intestinal antisep- can ever accomplish. Incidentally, Lusk has said that whole eat bread with but little of the bran removed is unfit for man consumption and that fine white flour produces less rogen loss in the feces and at the same time increases the num- of calories in the body. It would seem, therefore, that inence on whole wheat bread in the diet, to the discrimination the finely milled product, is nonsensical and unnecessary.[26]

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CHAPTER 10

FOODS IN THE PRESERVATION OF HEALTH AND IN THE TREATMENT OF DISEASE

ANIMAL FOODS

FOOD, environment, and metabolism form a powerful triumvirate in the acquisition of immunity, and therefore in the treatment of disease and the establishment of health, happiness, and longevity. Clinical experience teaches us to rely on foods rather than on drugs and medicines, except in particular instances and for short periods. Many nutritional diseases have an antidote in certain foods or food combination. "The right food is the right remedy."

In acute diseases, the child's body is surcharged with self-generated poisons which must be eliminated through the bowels, lungs, skin, and kidneys. The organism must have at its command all available nerve energy to counteract and to eliminate these poisons. During this period, the digestive work of the body is suspended, for nerve energy is as essential to digestion as it is to the physical and mental labor performed by the organism as a whole. In many instances, the eliminative organs cease to function, as do the other parts of the body. Excessive or too rich foods in a child's diet overburden the organs because these foods are not completely digested, but remain, in part, in the digestive tract, and decay, thereby forming poisons, gases, alcohol, and acids, which in turn are absorbed by the blood and add further to the disturbance. In fact, the addition of these toxins may so prolong the initial condition that the final sequence is death, which occurs when these poisons are generated faster than elimination or gases can carry them off. In an emergency, enemas help to clean out the lower bowel, but, contrary to general opinion, they make very little impression on the decomposing fecal matter in the upper tract.

Unquestionably the effects of weather and seasonal changes influence body function; resulting in reduced nerve energy, which is conducive to disease. Some children suffering from endocrine hypofunctions, particularly of the thyroid gland, are inclined to overeat. Too much food tends to cause sour stomach, gastric burning, and gas. Clinically, these conditions often give

it slight evidence of their existence, but they may progres-
vely result in nervousness, irritability, excitability, lack of self
ntrol, weariness, insomnia, despondency, gloom, and despair.
rare instances suicide has been known to occur.

Extreme nervous tension usually indicates a form of food
oisoning. Hunger is often the initial antidote. No one with
y sense of proportion and knowledge of biology and physiology
n read many of the estimates of food requirements for the
owing child as contained in certain textbooks, without a shud-
r at the amounts and kinds of foods recommended for body
aintenance. Incidentally, it has been stated that the required
loric count for a laborer is from four to five thousand calories
r diem. No mention was made of the kinds of food employed
make up this count or of its proper balance. According to
s report the unfortunate man would be required to consume
quarts of milk a day, baked beans, twenty ounces of butter
fat pork, three pounds of bread and three pints of butter-
lk. It is easy to imagine the intestinal intoxication and fer-
ntation that must follow.[1]

The child who is inclined to be studious, to behave well, and
be generally attentive, utilizes the same sort of nourishment
does his neighbor who refuses to study, plays truant, and
ks upon his teacher as his worst enemy. While the food
ue may be the same in both cases, the latter child expends
re nervous energy and thus requires a larger caloric carbo-
lrate intake, while his studious friend needs a more selective
tein diet.[2]

'ood for energy must be suitable in amount, kind, and char-
er to feed adequately the cells which compose the various
ans and tissues. The most carefully selected and proportioned
t contains much food material which is not entirely digested
l metabolized, and is therefore not utilized by the tissues of
body.[3] It is obvious, then, that the food products selected
st be of the type which will not break down into a number
oxic compounds in the alimentary canal, and must be able
convey the biologic and metabolizable constituents through
membrane.

leverting for the moment to the factor of heredity and the
nsmission of sound organs and tissues, one realizes the need
sound digestive tract and of a well-ordered metabolism in
parent, for the germ plasm is indelibly influenced by these
ditions. In general, therefore, an understanding of the forma-
of gastro-intestinal toxins is important in relation to all
lies concerning food in health and disease. Another im-

portant point is the possibility of a disturbed and faulty mucous membrane of the intestinal tract, which may direct into the blood stream incompletely digested albumins which may act as antigens or may prevent the natural passage of desirable nutritive substances.[4]

Where no gross dysfunctions are evident it is usually considered impracticable to endeavor to determine the exact quantity of each kind of food which should be eaten by a healthy child. Such a procedure would scarcely meet with the approval of either child or parent. Seemingly, however, one of the methods available for ascertaining these food amounts is to learn the general food consumption of the particular family and then apportion the total food used among the individual members. Needless to say, this method is very far from exact, and the quantities of food purchased, especially if measured in pounds, are much greater than the actual amounts that are edible. In this particular, experimental figures show a much greater degree of accuracy.

By careful studies and compilations of pertinent data it has been possible to set up averages in dry weight for the constituents in the normal diet. Thus we find protein to be 1/6, fat 1/6, and carbohydrates 2/3. In connection with the carbohydrate average we are inclined to overlook the role of white flour and sugar in the ordinary daily consumption of food. The protein average includes the amount received from both plant and animal proteins, the two figures being substantially the same.

When the infant is receiving practically all of its nourishment from milk it is getting protein 1/4, fat 1/4, and the other half carbohydrate; this being the approximate proportion of these nutrients in the solid matter of milk. But when the child is placed on a general diet he will be receiving along with larger quantities of other nutrients a larger proportion of carbohydrates from which he may draw energy for his increased activity. Such a diet apparently satisfies physiologic requirements. Of course no set figures can be followed exactly as to food rations since the need varies according to environmental factors, physical and mental stimuli, heat or cold, amount of exercise, rate of growth impulse, organic development, etc.[5]

There is sometimes a tendency on the part of parents to give their children foods that are far too hot to be taken with comfort. Infant milk modifications are often given at a temperature too high for complete digestion. The continued use of these excessive temperatures may alter the sensory nerves of the child's

ps and those of the taste buds, thereby causing the food taken ıto the mouth to seem tasteless. Even the sense of smell may be lunted and the enamel of the developing teeth injured. So vere may be these conditions that the ingested food reaches e stomach unmasticated and untouched by the saliva. In rare stances the mucous membrane of the stomach becomes hyper-mic, the mucous glands engorged.[6]

Even in young children, an excess quantity of meat and eggs the diet may overtax the liver and kidneys. Many children e the victims of fussy, well-meaning parents or guardians who ck common sense and a knowledge of proper food selection. this way initial dysfunctions are stimulated to greater activity. hrough ignorance the child may be denied many simple and sily prepared foods which contain adequate nutrients. These me parents often consider vitamins as nonsense, inorganic salts mythical, but meat as strengthening, eggs as "too binding," -containing foods as too rich, etc.

Bill boards, radio announcements, newspaper and magazine vertisements have made it extremely easy to procure the wrong ods and medicines and fairly difficult to obtain the right ones. e impressionable parent views with delight the over-fat, soft-shed, and rachitic infants as depicted in infant food advertise-nts, and rushes to obtain a package of the advertised product. us children are innocent victims.[5]

THE PROBLEM OF FOOD USAGE

Today foods are considered an economic problem, but in the ure, food economy will be studied even more closely both m financial and physiologic standpoints. By physiologic econ-y we mean the adaptation of the food supply to its best pos-le utilization by the various cells of the body. Largely within past ten years, food chemists have taught the value of food-ffs analytically and scientifically, but savages have for gener-ons shown their clinical adaptations. Scientifically, foods uld be so selected that each cell is able to obtain the particu-kind of nutrient it requires.

Especially in the larger cities, the rich purchase their food plies from expensive establishments where displays are pting and attractive but where perishable provisions may nain unsold for comparatively long periods. In this respect poor have a distinct advantage over their wealthy neighbors, their supplies come from outdoor markets or sidewalk stalls

where a rapid turnover assures fresher products. Moreover this rapidity in selling lowers the chances for insect and germ infection of the foods displayed for sale.[7]

A PRACTICAL CLASSIFICATION OF FOODS

The food of animals consists either of the protoplasmic body substance of animals or plants or of the materials which they have manufactured and stored away within themselves. The many kinds of substances called foods can be readily grouped. The first grouping, according to Burlingame, might be known as:—(1) Foods proper, or nutrients, and (2) Food accessories. In the "foods proper" group are those which yield energy or can be built into protoplasm. The "food accessories" are comprised both of inorganic and organic substances, such as the inorganic salts, and those others of an organic nature, whose value is becoming constantly more fully realized, the vitamins. These last are now known to be of vital importance in the diet, even though they are not nutritious in the sense that they furnish energy or constituents of protoplasm.

The foods proper are divided into carbohydrates, sugars, starches, fats, and proteins. These require digestion, either because when received into the stomach they are insoluble in water and thus cannot be taken up by the body fluids, or because they are not in such chemical form that the cells can use them. On the other hand, the accessories do not require digestion but are utilized by the body in the form in which they are absorbed.[8]

PROTECTIVE FOODS

A word should be said of what may be termed the "protective foods," this term having been first used by McCollum. As originally used, the term applied to milk and to the green leafy vegetables, since they were both rich in calcium and in vitamin A. Of late, this term has been given a more extensive meaning and now includes those foods which contain vitamin C, as well as foods which predominate in certain other needed nutrients.

Modern science still recognizes in milk an outstanding example of all the factors so necessary to child nutrition. The richness of eggs from the standpoint of their vitaminic content places them in this class of "protective foods." Although high in nutritive value, eggs must be used with caution, since they do not possess the property of reducing intestinal putrefaction or of promoting the growth of normal bacteria in the digestive tract.[7]

NUTRITIONAL CHARACTERISTICS OF COMMON FOODS

Perhaps most of the common foods had best be summarized cording to their outstanding and significant nutritive qualities well as from the standpoint of a knowledge of present day lues:—

(1) Breadstuffs and other grain products are economical sources of energy and of proteins, but are not satisfactory sources of mineral salts and vitamins.

(2) Sugars and fats are important chiefly from the nutritional standpoints as sources of energy; some fats are valuable in that they contain the fat-soluble vitamins.

(3) Meats, including fish and poultry, are rich in animal protein, in fat, or in both. However, they lack the necessary inorganic salts and vitamins, as do the grains.

(4) Fruits and vegetables vary greatly in their protein and energy values, but are highly important sources of mineral salts and vitamins.

(5) Milk is important as an energy producer and contains mineral salts and the vitamins. It is the most perfectly balanced food known to man, but it is a quality rather than a quantity food.

(6) Nuts are richly endowed with proteins and fat and are, in many instances, of greater nutritional worth than are meats.

(7) Eggs, which are included under the animal foods, may be considered as consistently fitting in an intermediate position between meat and milk. They are listed under the protective foods, although they cannot be used with benefit in all cases.

udging from observation, the European diet is on the whole of economic security and sound knowledge of nutrient ues, also in general it is free from whims and caprices. This, ortunately, is not generally true in America, where palate sfaction reigns supreme and too many breadstuffs, meats, , and sweets are eaten.

o further amplify pertinent data on food values one can do better than quote examples cited by Sherman. Field workers n the United States Department of Agriculture and the New k Association for Improving the Condition of the Poor have le a dietary study of what they considered to be 22 typical

families. They reported an average food value per man per day as follows:—

Energy	3,256.	Calories
Protein	106.	Grams
Phosphorus	1.63	Grams
Calcium	0.74	Grams
Iron	0.179	Grams

A comparison of these averages with actual requirements shows that there is a decided protein surplus, a fair supply of phosphorus and iron, but comparatively scant amounts of calories and calcium. In general, American food habits show conspicuous inconsistencies. For instance, our protein need is less than 100 times our calcium need, while our protein intake is over 140 times our calcium intake; or conversely, our calcium need is over 1.0 percent of our protein need but our calcium intake is only 0.7 percent of our protein intake.

Bachmann and Bliss have given us a detailed table of actual food principles as follows:—[3]

CLASSIFICATION OF FOOD PRINCIPLES

Principle	*Where Found*
	Inorganic
Water Sodium and Potassium chloride Sodium, Potassium and calcium phosphates and carbonates Iron	In nearly all animal and vegetable foods
	Organic
Carbohydrates	
Dextrose or grape-sugar Levulose or fruit-sugar	In fruits
Lactose or milk-sugar	Milk
Saccharose or cane-sugar	Sugar-cane, beet roots
Maltose	Malt and malted foods
Starch	Cereals, tuberous roots, and leguminous plants
Glycogen	Liver, muscles
Proteins	
Myosin	Flesh of animals
Albumin, vitellin	White and yolk of egg
Caseinogen	Milk
Serum albumin, fibrin	Blood contained in meat
Gliadin and glutinin	Grains of wheat and some cereals
Vegetable albumin	Soft-growing vegetables
Legumin	Peas, beans, lentils, etc.

CLASSIFICATION OF FOOD PRINCIPLES (*Cont.*)

Principle	*Where Found*
	Organic
ts	
imal fats	In adipose tissue of animals
getable fats	In seeds, grains, nuts, fruits, and other vegetable tissues
getable Acids	
ric, tartaric, acetic, malic	In fruits and vegetables
amins	
amin A	In milk, butter, egg yolk, cabbage, spinach, carrots, germs of cereals, green leaves of plants.
amin B	In yeast, milk, cheese, eggs, liver, pancreas, beans, peas, germs of cereals, oranges, tomatoes, lemons, apples, grapes, honey, potatoes, carrots, turnips, and nuts.
amin C	In raw cabbage, lemons, oranges, tomatoes, potatoes, carrots, bananas, apples, turnips, lettuce, watercress.
amin D	Milk, butter, cod-liver oil.[3]

HE DIETARY STANDARD AS A GENERAL PROBLEM

Observation confirms our belief that children when eating rious foods because of a real hunger urge seem to take just e quantities which are biologically proportional to their energy quirements. Whether or not these amounts meet the cell reirements at the same time, we have no way of ascertaining. e are also without definite information as to the performance each nutrient in metabolism. Hunger and appetite have a imary role in the child's diet, but the guidance of the parent, pecially as to the quantity of food, should not be minimized.

There are many reasons why the child's natural hunger urge subject to variations, and with it, the appetite. It is obviously possible to follow a set rule for foods and quantities. Many empts have been made to apply an accurate measurement of e development of a child from the standpoint of nutrition. ldwin, no doubt, voices the opinion of many investigators en he says, "normal growth in weight and height is probably e best single index of good health and consequently of good trition during childhood." It may be added that normal owth in weight and height is dependent on what is normal in trition and environment for that particular child, taking into count its race, strain, etc.[7]

STANDARDIZED RATIONS

While it is understood that exact dietary standards cannot be generally arranged because of restricting circumstances, it is realized at the same time that there are normal percentages of certain foods beyond which the child may not go with impunity. Wherman suggests that one gram of protein per kilogram of body weight be given daily. As it works out, however, it is particularly difficult to measure proportionate quantities of the various nutrients, especially in the case of the diet for younger children. Another suggestion has been to allow 10-15 percent of the total allotted energy to be in the form of animal protein.

During the years of rapid growth, a considerable part of the ingested food is utilized in the synthesis of body proteins, but since the amount of food proteins required to form a gram of body protein is variable and depends largely on the amino-acid make-up of the food proteins, it is evident that the kind of protein supplied must have a distinct bearing on this picture.

Another difficulty in considering a possible standardization of the amounts of nutrients, is the fact that during growth the demand of the cells for certain substances is increased and therefore the need for the food containing the particular substance or substances would be temporarily greater than the amount included in any estimate. Indeed, the demands of the growing organism may be so urgent that they cannot be computed in terms of the ordinarily measured total food requirement, and a shortage of an essential food principle of whatever kind may, sooner or later, make itself apparent symptomatically. In these cases the child's energy is diminished, the body and mind are stunted, growth impulse and development are restricted, and, in extreme cases, malnutrition and even death may follow.[7]

FOOD QUOTA IN THE NUTRITION OF CHILDREN

During the World War, Miss Gillet of the United States Food Administration Bureau issued a simple and practical food budget for families which was substantially as follows:—

Divide your food into five parts
- 1/5 more or less for vegetables and fruits
- 1/5 or more for milk and cheese
- 1/5 or less for nuts, fish and eggs
- 1/5 or more for bread and cereals

1/5 or less for fats, sugar and other groceries, and food adjuncts.[7]

HUMAN INTELLIGENCE AND FOOD

Frankly speaking, the question as to what is best for healthy ildren to eat can only be answered in a general way. Each ild has certain biologic prejudices and preferences, these latter some cases, no doubt, being man-made. In any discussion of rrect food from a scientific viewpoint, one naturally disregards nims, illusions, and obsessions as indulged in by the food natic. Food laboratory tests on rats, pigeons, dogs, etc., have oven very valuable in scientific work on foods for children.

Civilized man is largely dependent for his food supply on stoms, habits, traditions, sectional and racial laws. Social and igious food customs are still handed down from generation generation and are strictly observed. An abundance of wealth, eness, and leisure all contribute to improper and excessive ting. The multiplicity of canned and manufactured foods nich no longer require any preparation at home have changed ny a potential housewife into a habitué of the divorce court. norance is shown by rich and poor alike regarding the eco- mic value of foods and the true relationship between price d nutritive worth. An economist with a mathematical turn of nd has figured that poor people pay nearly a dollar per pound coffee by buying it in small quantities.

Among many groups of immigrants there is an urgent demand over- or under-cooked or highly seasoned dishes which cor- pond to those of their youth or homeland. In some households e meals are dreary social functions without fun or laughter d the members of the family eat whether or not they have any petite at the time. In some instances a nutritional disease or endency to one has been incited.

There is the possibility that the young clinician may become engrossed in studying full-blown disease manifestations that ese unobtrusive tendencies and early departures from the rmal are neglected.

If one were willing to place nutrition on a purely caloric sis without regard to individual digestion, absorption, or tabolism, it would be a simple matter to obtain a total caloric unt from single articles of food. On the other hand, it would quite possible to take food substances one by one, weigh h, calculate the caloric value, at the same time noting its di- tibility, its absorbability, and its metabolizability. Under such

happy circumstances these substances could then be utilized for the building up of a scientifically prepared diet for the individual child. However, what mother, even though she approved of this procedure, could afford the time, money, or patience required to carry it out? [9]

INTELLIGENCE IN CHILDREN

The question is often asked by mothers, whether a carefully planned diet has any marked influence on the intelligence of children. It is known that certain foods stimulate growth impulse, growth, and development, then why not the intelligence? As the brain, or its tenant, the mind, is an integral part of the child's organism, and as the psychologic activities of the mind are necessary to the physical reactions of the body, this question of food and intelligence is of vital importance to every parent.

Heredity and environment are fundamental yet far reaching factors in the mental development of the child, and foods form an immeasurable part of this environment. John Monroe has given sixteen years to the study of intelligence in children. He found a remarkable and direct relationship between intelligence and nourishment in the children from the intelligent and the more well-to-do middle and upper classes, who have a far greater chance to become mentally endowed than do those of the poorer classes who suffer from malnutrition. Much of the low grade intelligence of the laboring classes is due, he believes, to their poor and insufficient food. The same investigator conducted a little clinical experiment of his own which may illustrate the point. To ten children of fairly intelligent families he fed eggnogs twice a day over a period of seven months. At the end of that time he believed that nine of them had an increased intelligence quota.[10]

Using bees, Conklin conducted an experiment on the influence of foods on development. He found that if the larvae of bees were fed on "royal jelly," which is a bee food rich in fat, they became fertile and females and queens were the result. If, on the other hand, they were fed on ordinary "bee bread" there was less fertility in the production of the workers. It would seem that these differences, whether of body structure or of instinct origin, are determined by the character of the food and not by heredity. While these experiments are by no means conclusive evidence, they do provide food for thought.[11]

To get back to the parent's question regarding the proper food for children for promoting the greatest possible degree of

elligence, growth, and development, one finds that many of e ordinary foods are entirely suitable for the purpose. Inci-ntally, cod liver oil is essential for vitamin A, and the foods ntaining inorganic salts are beneficial in activating nutrition, ile the value of milk need scarcely be mentioned. According Tso, egg yolk possesses the special property of increasing the cium assimilation of calcium-containing foods and thereby res the excess of calcium intake which would otherwise be quired for food. His preliminary tests on rats would seem to licate that egg yolk given in equivalent amounts in terms of oric values, is nearly as efficient as is milk in promoting rmal growth in the young.[12]

MASTICATION

When speaking of the digestibility of foods, their adaptability ough mastication should never be overlooked. Fermenta-n, with its resulting formation of carbonic acid gas and alco-, and putrefaction with its subsequent toxins, are produced from dietitic errors alone, but in no small measure from a lty pre-intestinal preparation of foods. Foods not thoroughly wed cannot be properly digested and assimilated. Mastica-n is the first process of digestion, for in this manner the food mechanically and chemically prepared for the next stage. e proper flow of saliva and of the intestinal juices is de-ndent on the manifestations of the physical and sensory nuli. Real hunger, not the pseudo variety, is a strong stimu- to this end. When proper mastication is ignored, unques-nably the keen desire for food becomes blunted, as the mach and intestines are engorged with improperly prear-ged substances.

But the process of mastication is understood differently by erent people. Some years ago it became the fashion to cherize all foods eaten; in other words, food was chewed in mouth until it became an insipid, tasteless mass. In reality, food became so excessively impregnated with saliva that gas- digestion was interfered with. Many animals and many chil-n prefer to bolt their food after a moderate amount of masti-on. As a matter of fact, a healthy young child may do so h impunity, for the normal stomach at an early age is biologi-y prepared to accept this partially masticated mass.

However, a sensation of pseudo hunger in children due to ermotility of the stomach has very little similarity to the mal urge. This condition may rob the child of the pleasure

to be derived from eating and it becomes the habit to gulp down food almost without tasting it.

Some foods require a much longer period for mastication than do others. This is true of the starchy foods, such as bread, potatoes, cereals, etc. Some older children apparently find pleasure or satisfaction in overdoing mastication. They sometimes chew gum, toothpicks, and various other non-edible objects. In this way the salivary glands become exhausted and are not equal to the performance of their natural functions.[1]

Indeed, many of the foods eaten in a raw state are rendered tasteless by too thorough mastication. We are all familiar with the numerous so-called breakfast foods which are so picturesquely exploited. In many cases they contain sufficient calories and nutrients, but their firm consistency makes them impervious to milk or cream and they are therefore unsuitable. In nature's laboratory, foods are compounded so that their nutrients harmonize. In many cases these food materials are taken by the manufacturer and completely devitalized. Sugar is overrefined, flour is overmilled, the character of corn meal is completely changed, rice is polished, and barley is pearled, etc.[1]

DIGESTIBILITY OF FOODS

It is useless to talk about foods for growth and physical and mental development unless the child finds them pleasing to his palate and the cell finds it possible to metabolize them. By digestibility is meant the utilization of food substances as shown by the amount of food present in the diet and the amount excreted in the feces. Utilization of the proteins, fats, and complex carbohydrates depends chiefly on, and is a measure of the digestibility of these food substances.

The inorganic salts and the simple sugars do not require digestion. What is really measured is their ability to be absorbed. It is recognized that all measurements pertaining to nutrition can be corroborative in part only. This is accounted for by the varied body reactions brought about by the difference in both mental and physical stimuli. In rickets, calcium absorption is believed to be of fundamental importance and hundreds of experiments have been carried out along those lines. However, investigators apparently prefer to use as measures of calcium absorption the rates of growth in animals or the formation of lines of calcification to the bones. While these methods are valuable they are by no means quantitative measures of calcium absorption. It would appear at times that many scientific

od utilization experiments on the human organism are shunted ide for more spectacular research, for the former take a large nount of time and patience and substantial rewards are not sured.[13]

MONEY EXPENDITURE FOR FOOD

Many parents are under the impression that the scientific trition of children entails a larger expenditure of money than ey can afford. This is untrue, for the best and most suitable ods for infants and children are usually reasonable in price. om dietary studies made by the United States Bureau of Labor tistics, the United States Department of Agriculture, and the w York Association for Improving the Condition of the Poor, has been estimated that the money devoted to the purchase of d by the average American family is from 30-35 percent for ats and fish, including poultry and shell fish; about 5-6 per- t for eggs; 8-10 percent for milk; 7-12 percent for butter and er fats; 10-20 percent for bread, cereals, and bakery products; percent for sugar and other sweets; 7-12 percent for vege- les; 2-8 percent for fruit; and less than two percent for cheese l nuts, two of the most valuable foodstuffs in nutrition.

Grain products, which include all breadstuffs, cereals, etc., are nd in abundance in many diets on account of their low cost. mittedly, they give a high return in calories, vegetable pro- ns, and phosphorus, but when eaten in large quantities there he probability that vitamins and other essential food prin- les will be lacking in proportion.

Unbiologic food deficiencies and excesses may be easily and aply corrected by giving preference to milk, vegetables, and ts, in suitable proportions, in order to satisfy the needs of the cells of the body. Vegetables and fruits may be ranked t to grains in efficiency, for they tend to correct both mineral and vitamin deficiencies of the latter. Finally, children's in which milk and milk products, vegetables, fruits, nuts, meat, and carbohydrates are well proportioned are usually in cost but high in energy, growth, and developmental value, they contain all the necessary nutrients for the balancing of abolism.[7]

NUTRITIVE PROPERTIES OF ANIMAL TISSUES

There exists in the lay mind a distorted comprehension of y foods, but especially is this true of the animal proteins.

Even some individuals who make a scientific study of foods advocate a diet rich in meat proteins and low in animal protein. It is certain, however, that within reason the proteins are the sovereigns of the nutrient kingdom.

Many physicians make a biologic difference, or at least a clinical difference, between animal and vegetable proteins, and they assume that children require a proportionate quantity of each. McCollum has pointed out that the mineral content of animal tissues resembles that of the plant seeds. The latter, however, are not as satisfactory a nutritive source of this element. In gauging the different types of proteins as found in the various kinds of animal tissue, one will no doubt experience difficulty in obtaining just the data he requires when planning a highly specialized diet.

Osborne and Mendel found that young rats grew on a diet restricted to eighteen percent of protein which had been obtained solely from the liver, kidney, muscle, and brain. Incidentally, the toxic nature of many glandular organs which act as powerful physiologic stimulants makes them unfit for food. Two of these substances are thyroxin and adrenalin, contained in the thyroid and supra-renal glands, respectively. Indeed, the value of liver should not be overstressed. Certain of the so-called uncivilized peoples never eat it. The Eskimo does not eat the liver of the reindeer, the polar bear, the seal, and particularly that of the dog, which is considered very poisonous.

In man, the liver is concerned with many of the phases of the transformation of organic substances through metabolism. It is known that the glandular organs are rich in cell nuclei and yield considerable amounts of the purins, which are ultimately converted into uric acid. In children, rare instances are found in which the excretion of uric acid and the urates is interfered with, making it impossible for liver or kidney products to be included in the diet.

An example of ignorance regarding proper nutrition is found among the natives of Labrador and Newfoundland. In former times their diet consisted of wheat flour, molasses, fish, meat, tea, and raisins. Scurvy and beri beri were rampant among them then, even though they had at hand an abundance of fish liver rich in fat-soluble A and water-soluble B and C.[14]

ANIMAL PROTEIN IN EXCESS

While laboratory workers have stressed the importance of animal proteins in the diet, it is equally true that the organs of a

eptible child may be affected detrimentally by an excess of se proteins. Clinical findings apparently indicate that the neys are the organs most frequently affected. It is possible an unrecognized hypertrophy takes place where the protein ke exceeds one third of the food fuel in the ration. There is on to believe that a disease retrogression in these and in other ans takes place if the diet is placed on a more balanced s.[15]

THE SIGNIFICANCE OF ANIMAL FOODS IN INTESTINAL PUTREFACTION

ome of the most common disturbances of infancy and child- l are those relating to the gastro-intestinal tract. Fortu- ly, from the work of many investigators, we are in possession certain amount of knowledge concerning the influence of ous foodstuffs on the intestinal flora and their relationship he extent of intestinal putrefaction. Experiments with egg min, meat powder, peptons, gelatin, and casein showed that albumin had the highest reduction percentage, and casein owest. Casein, in the form of cheese, is the least liable to efaction in the intestine.

his high reduction percentage in the case of egg albumin be due, in part, to its high sulphur (custin) content, giving o the formation of large amounts of the powerful reducing ance, hydrogen sulphide, which is solely a product of efaction and is toxic to a high degree. Especially in the , the power to oxidize this sulphide is very limited, there- if a child has a characteristic potential digestive dysfunc- the egg intake had better be limited. Its toxic action is not ted to the hemoglobin but to the nerve cells, and children suffer from its effects in headaches, dizziness, depression, etc. toxicity of hydrogen sulphide may assume even a more is aspect, as it is known that certain vitamins as well as substances are destroyed by its toxic action.[16]

UBSTANCES WHICH ANTAGONIZE HYDROGEN SULPHIDE

e carbohydrates and fats play a happy role in combatting poisons generated by hydrogen sulphide. Possibly more ic digestive disturbances arise from this agent alone than any one other source. The symptomatology of the effects is poison is often deceptive and is frequently confusing,

and many a diagnosis and prognosis has been made entirely out of keeping with the related cause and effect.

The soluble carbohydrates, such as glucose for example, are found to decrease putrefaction, first by furnishing a readily available source of energy, one to be preferred for this purpose to the protein of many bacteria. The result is a decrease in the amount of decomposed protein. Also, the acid products formed from glucose produce a medium less favorable to the growth of putrefactive organisms. Glucose, however, when ingested is absorbed so quickly that it has as a rule but little opportunity to produce the desired effects in the large bowel, and is not as useful as are lactose or dextrin, which, in part, reach the colon and profoundly modify the intestinal flora. Clinical experience, however, leads us to believe that raw brown sugar acts better in many respects in these cases than do the predigested carbohydrates.

Certain investigators have discovered, in a series of tests, using different carbohydrates and 20 percent of egg albumin, that starch, sucrose, maltose, glucose, and fructose brought about but little alteration in the intestinal reduction, which was probably because of a lack of oxygen, and any starch reaching the large intestine is broken down too slowly for the sugars formed to exert a pronounced effect on the intestinal flora. The bowel movements after the use of lactose and dextrin were found to be acid in character, laxative, and soft.

Bergeim showed in his series of experiments with boiled egg cheese, peanut butter, cooked and dried meat, raw meat, powdered milk, soda crackers, and bread that the highest reduction values were obtained by the egg and the lowest by the powdered milk, the milk being of importance, due to its lactose and casein content, in intestinal putrefaction which resulted from an excess of meat and eggs in the diet. The influence of fruits and vegetables combined with cheese and sugar upon reduction cannot be overestimated. In bananas, oranges, pineapples, raw and cooked apples, raisins, lettuce, cole slaw, turnips, and some other foodstuffs, there is found an armory of weapons against many intestinal diseases.

It has been observed, too, that certain food combinations give different reduction values. For instance, boiled eggs with bread show a higher reduction value than is observed with cooked meat and bread, while cheese and bread diets give lower values than do eggs. Peanut butter, so much favored by children, gives rise to no intestinal putrefaction. Whatever may be the percentage strength of the vegetable proteins as contrasted with

ose of meat and eggs, they certainly bring about no formation putrefactive toxins. Fruits and certain vegetables are strongly iputrefactive because of their high carbohydrate content, on ount of their vegetable protein ratio, and also on account of ir laxative effects. Also, lettuce, cabbage and its juice, celery, nips, oranges, apples, pears, berry juices, pineapple, and many er fruits and vegetables have proven, in many cases, almost a acea against intestinal putrefaction.[16]

HE PROPERTIES OF THE AMINO-ACIDS, GLYCIN AND ALANIN

he new-born infant has a certain food reserve which is ob-ed from the mother and is proportionally large or small ending on her nutrition. Is this food storage made up partly lycin and has this product been "carried over?" Suppose, instance, that this new-born baby subsists wholly on natural , the proteins of which contain no glycin, yet we know that capable of adding to its own store of body proteins which ain the amino-acids. Is it not probable, then, that this sub-ce must be built up within the baby's body? Also, do we not that the more glycin present, the greater is its specific on? Is it not logical to believe that the gradual exhaustion is important amino-acid without repletion might lead to a red vitality and perhaps to death?

the proper nutrition of infants and children, a large number roteins must be employed, up to a certain degree. Rubner laid down the dictum that the specific dynamic action of a ein is proportional to the amounts taken into the body. In a s of experiments, this authority fed beef in increasing quan-, beginning with 200 grams, then increasing it to 400 and o, and finally to 800, finding a resultant specific dynamic n increase with each 200 grams. An increase in heat produc-of about ten percent was also noted.

hen the amino-acids, glycin and alanin, were given together was a definite summation of effect. These two amino-acids ound in a large number of proteins and seem to be closely ed. It may be that certain proteins tend to neutralize each . This, if true, would emphasize the need of adding still proteins to the child's nutrition. Both animal and vege-proteins, then, would be consistently required. Unfortu-y this conclusion cannot be demonstrated. However, the nstrable power of casein and gelatin to neutralize the ic dynamic action of glycin suggests this possibility. In

short, the child, after a meal of meat, might neutralize its effects by eating cheese and gelatin products.

Many of nature's functional activities are obviously quite beyond our understanding. It is impossible to measure the hourly nitrogen excretion rate, if one should desire to know the amount of protein; and food principles have a different absorption time in the intestines.[17] In the liver, much gelatin is found which is seen as lecithin, a fat rich in phosphorus.[2]

THE DANGER OF CYSTIN

As in the case of certain other amino-acids, cystin must be used with caution, for it is but a step from its useful to its harmful effects. Newburgh and Mendel have discovered that while cystin is necessary to health, in overdoses it becomes dangerous. However in their experiments on rats they found that when this amino-acid was reduced to three parts in 10,000 of their diet, the little animals failed to grow adequately, but twice that amount proved sufficient for health. A further increase of cystin became harmful, while a decided increase caused death. It may be difficult to believe, Newburgh states, that such an essential substance is capable of damaging the liver, but he believes that it can happen.[17]

PROTEIN PERCENTAGES ON HIGH AND LOW NUTRITIONAL DIETS

Laboratory and clinical experimentation may often vary widely in their conclusions, but there are times when these tests parallel each other. In general, children seem to do better on a diet somewhat restricted in animal protein, abundant in vegetables. With some children health and development are curtailed by an intake of an over-abundance of animal foods, particularly those tending to create acid, while other children apparently suffer no harmful effects. The correct answer may lie in a study of the acid-base balance of the individual child and in a more rational understanding of its inherited states and potentialities. No child, it would seem, can remain for long on an even keel between acidity and alkalinity, but the problem is to find out if possible how far the child can swerve in either direction without harm. If this could be ascertained clinically from the symptoms it would be an easy matter to suggest certain animal or vegetable proteins in suitable quantities for the maintenance of health.

Much could be learned also if it were possible to make daily observations over a period of years on a large number of children. It is equally difficult to control the food intake and the environmental conditions which make a shifting from base to acid or from acid to base.

Mitchell wisely concludes that with proteins, as with other food substances, successful nutrition, continued health, and potential longevity are possible with a wide intake of foods, and no diet should contain too little or too much of any one kind of food element.

Animal proteins in adequate amounts are obviously necessary for a child. Hoagland and Snider have demonstrated that the animal varieties are the better for growth. In general, however, the various proteins in suitable amounts seem most essential.

Considering for the moment the quantity of the necessary protein ration in relation to longevity, Glasser in 1923 offered the results of his experiments and observations on the common house fly. The life span of this insect varies from one to eight days. When fed exclusively on proteins, no eggs resulted; when sucrose was fed, the life span was lengthened, but there was no egg laying; however, when the two were combined, both eggs and a longer life resulted. This would seem to point to the need of a mixed diet.

In the main, investigators agree that a high protein diet may produce an increased urinary nitrogen and hypertrophy of the kidney. One finds but scant mention of the effects on the other organs of the body. Clinical experience indicates that a disproportionate diet of meat and eggs tends to devitalize the body, with possible resultant colds, bronchitis, pulmonary congestion, or pneumonia. Frequent disturbances along the alimentary tract, especially in the large intestine and colon, and severe constipation, often accompanied by a dilatation of the lumen of the intestines and resulting from an accumulation of gas formed by gas-forming bacteria, may favor far-reaching infection diseases. We realize that we are liable to criticism when we make the statement that possibly appendicitis, high arterial tension, and certain types of tumors may be the outcome in some cases of an unbalanced metabolism resulting from an excessive intake of animal protein foods.[18]

THE DYNAMIC ACTION OF PROTEINS

Both animal and vegetable proteins are of great dynamic importance. Beef is found to contain four percent of glycin and

eight percent of alanin; gelatin contains approximately 26 percent of glycin and nine percent of alanin; casein contains no glycin and one and one half percent of alanin. Gliadin contains two percent of alanin but no glycin. Knowing the foods in which these amino-acids are present and knowing their percentages, will it not be possible to achieve more satisfactory results in feeding problems?

Lusk came to the conclusion that the specific dynamic action of protein in stimulating metabolism was due chiefly to the amino-acids, glycin and alanin. Fish, according to Osborne and Jones, contains no glycin and a questionable amount of alanin, while chicken contains 0.68 percent of glycin and 2.28 percent of alanin. Therefore, when these two elements are indicated in the diet, those foods which do not possess them must of necessity be omitted in nutrition. It is interesting to note that the specific dynamic action of both codfish and chicken have been proven to be substantially the same as that of beef. Thus when 218.2 grams of codfish were given in food tests, the metabolism rose to a level of 22.21 calories per hour, and when 157.1 grams of chicken were given, the heat production was raised to 21.59 calories per hour. Both substances contained six grams of nitrogen. While both these animal proteins showed a widely different amino-acid content they proved equally powerful as stimulants to a higher heat production in the body.[19]

THE PRACTICAL APPLICATION OF FOODSTUFFS IN NUTRITION: MEATS

Meats are animal proteins. It is well to give careful consideration to their physical composition so that they may be contrasted with the composition of other foods. Meats are made up of muscle fibers which are held together by connective tissue composed largely of lactin and collagen. Each fiber has a sheath or covering, and within the fibers are contained the meat juices, which are solutions in water of both protein and of non-protein nitrogenous extraction. The proteins of these juices consist largely of globulin, myosin, muscle albumin, hemoglobin, and other salts. Muscular tissue is composed almost entirely of nitrogenous material. There are no peptones found in living muscle, but the ferment, pepsin, is present. After the death of the animal, and through the action of pepsin in the presence of lactic acid, muscle is partly digested so that both peptones and proteins are contained within it. This is the process of maturing meat for food. Muscle also contains a carbohydrate, glycogen or

nimal starch. These substances are formed from the sugars and e absorbed in the digestive tract.[20]

Meat proteins have the property of stimulating both the stric secretions and the endocrine system, particularly the yroid gland. They give to the body a feeling of warmth d satisfaction, even more than do the fats and carbohydrates, though the isodynamic value of both fat and carbohydrate is uch greater than that of protein. After a badly proportioned eal of meat there is a feeling of general well-being, which is lowed, however, by depression. The young child, after such a eal, may become sluggish, apathetic, or irritable, while older ildren complain of weariness and lethargy and in school are nsidered stupid.

If this diet is continued for an extended period, the intestines come clogged and fertile culture media for pathogenic bacia, and poisons are formed by the putrefactive processes. Sulo ether is often found in the urine. Although meat even in ess may at times be well digested, this over-supply tends to ed up metabolism unduly and to intoxicate and acidify the od. It also overexcites the endocrines, especially the thyroid, elerates metabolic waste, and is found to be a marked irritant he central nervous system. On the other hand, meat, in small asured amounts, acts on the nervous mechanism as a general ic. In excess it acidifies the blood, for its ash is acid in reac-n, having phosphoric acid as its base. When this over-ndance is not completely oxidized it gives rise to uric acid. he carnivora this acid is counteracted by an adequate amount mmonia.

Vhen the alkalinity of the blood is reduced to a danger it by too much meat, the organism loses its resisting power lisease. We are firmly convinced that in early life meat in nced proportion is decidedly essential for the normal bio-c activities. However, from middle age on, the meat proteins uld consist of chicken, pigeon, hare, duck, or goose, for all e have a very easily assimilated nitrogen make-up and their cles are tender. Their meat contains fewer extractives than of the larger herbivorous animals and is less apt to irritate internal organism.[2]

DETAIL RELATING TO THE CHEMICAL COMPOSITION OF MEAT

chemical analysis of meat shows that its connective tissue s 2.0 to 3.5 percent of gelatin, sarcolemma elastin, and

nucleo-protein. Muscle plasma contains myosin, about 12.0 to 14.0 percent, and about 1.5 to 3.5 percent of serum albumin. The proteins of meat in either the fresh, raw, cooked, dried, pressed, or extracted state are of great biologic value.

The meat bases contain mainly creatin and creatinin in percentages from 0.10 to 0.38, also the purin bases, xanthin and hypoxanthin, in percentages of 0.13 to 0.26. They also contain 0.07 to 0.25 percent of inosin, cornosin, alanin, valin, and other amino-acids. The fat glycerides of palmatin, stearin, and oleic acid are likewise found, as well as a 0.1 to 0.2 percentage of the cholesterin content of meat fat. There remains the 2.6 to 3.0 percentage of lecithin. As carbohydrate, glucose is found in 0.05 to 0.18 percent. Also there is present a 0.8 to 1.8 percent of calcium, calcium phosphate, and sodium chloride.

Even the vitamins A, B, and C are found in raw meat, but in small quantities. Many experienced Arctic explorers have prevented the occurrence of scurvy and other deficiency diseases by eating raw meat.[21] The Arctic Circle is, for the most part, a huge ice box where meats and other foodstuffs do not readily deteriorate.

In Europe the school children often satisfy their hunger with raw meat sandwiches. In Germany all meats are inspected by the government, a regulation certainly essential when meats are to be used without cooking. Naturally, emigrants from the countries whose custom it is to use meat raw bring the habit to the new country. It is not unusual, therefore, in some parts of England and America, to find raw meat dishes served.

Occasionally in the city the physician is confronted with organic disturbances resulting from improper meat inspection. Feasting on a hospitable soil may be found the taenia solium, taenic mediocanellata, taenia echinococcus, the bothriocephalus, and the trichina spiralis. From the eating of undercooked pork and sausage and also of raw beef, trichinosis and tape worm are frequently discovered in communities where foreigners colonize. Indeed, the liver, kidneys, heart, and brain may contain large numbers of parasites. In treating the children in these localities it is necessary to inquire in detail into their food habits. If soda is added to the water in which meat is cooked, or if some form of pickling is added, or if the meat has been smoked or dried, the parasites will be destroyed, but the vitamins will be lost also.[21]

THE IRON CONTENT OF MEAT

The objectionable qualities of meat are widely discussed, but ne cannot overlook one of its advantageous features, namely its ron content. In ordinary muscle meats, iron is present chiefly s hemoglobin, a circumstance due partly to the muscle cells nd partly to the retained blood. As fatty tissue contains a inimum of iron, lean meats are preferable. In general, ac- ording to Sherman, meat averages about 0.00375 percent of on.[7]

Whipple, Hooper, Robocheit, Robbins, and others have dem- nstrated that the curve of hemoglobin regeneration in the body n be influenced at will by the various dietary factors. It is nown that the liver, heart, and skeletal muscles are very potent effecting the rapid production of hemoglobin and of the red lls. Calf or beef liver fed to older children, and chicken liver younger ones, when both groups are suffering from anemia, ill provide the maximum regeneration of hemoglobin.

It is also probable that many other organs of the body con- in some iron. Organic foods are, on the whole, much richer iron than is "carcass" meat, while beef spleen, liver, kidney, d blood contain much more iron than do most foods of vege- ble origin. Beef and veal possess two thirds more iron than do rk or lamb and ten times as much as milk. Beef heart and ain have twice the iron content of muscle beef, beef liver, twice at of beef heart, while the spleen contains half as much ain as the beef liver. Beef contains twice as much iron as pota- es, two and one half times as much iron as white flour and corn eal, and eight times as much iron as is found in apples. On e other hand, some vegetables, mainly peas, beans, lentils and nach, contain more iron than does beef.[22]

MEAT EXTRACTS

n the medical profession are to be found, in about equal mbers, defenders and dissenters in regard to the use of meat racts in infant and child nutrition. Many clinicians consider se extracts solely appetizers. The manner in which these stances are processed should be largely influential in decid- upon their use. Under the heading "meat extract" is rightly derstood an albuminated, gelatin-free, and fat-free water ex- ct of meat. This meat is heated in water, filtered, and then porated in a vacuum. The finished extract should contain result of the hydrolysis of the proteins and the amino-acids,

the groups including phosphorus acids, inosite, glycogen, lactic acid, succinic acid, acetic acid, and the phosphates and chlorides of the alkalis. In the composition should be also a goodly proportion of vitamin B, as well as traces of A and C. Even as great an authority as Rubner, however, pronounces these extracts valueless as a source of real nutrition, claiming that their purpose is merely one of exciting the gastric secretions.[21]

POULTRY—A COMPARISON

For some years it has been our custom when initiating the meat ration in early childhood to begin with poultry rather than with coarser meats. The meat of chicken, duck, turkey etc., have approximately the same nutrient food percentages as have other and less digestible animal foods. The edible portions of these foods contain about 19.3 percent of protein, 16.3 percent of fat, and a caloric value of 1.017 per pound. Young chickens or broilers have a protein percentage of 21.5, of fat 2.5, and a caloric value of 493 per pound. Turkey yields 21.1 percent of protein, 22.9 percent of fat, and has a caloric value of 1.320 per pound.

Comparative figures for steak are, protein, 21.9 percent, fat, 20.4 percent, and a caloric estimate of 1.230. The forequarter of mutton consists of protein, 15.6, fat, 30.9 and a caloric value, 1.543. Pork chops are, protein, 16.6, fat, 20.1, and a caloric value of 1.530 per pound.

In general, poultry meat has a finer texture, a minimum of connective tissue, contains highly nutritious and digestive qualities, and lends itself easily to an initial meat diet. Beginning with poultry, other meats may be added gradually, lamb being preferably the first.[7]

FISH

Because of the nature of fish as a food it lends itself easily as a substitute for meat proteins. Though the flesh of fish is not as stimulating as meat it contains as much nitrogen. Its texture is tender and there are fewer muscular fibers and less connective tissue. When, as is most important, fish is used fresh, its digestive qualities are even greater than those of meat. Among children, the pediatrician finds fewer intestinal disturbances resulting from its use. The extractives found in fish are only mildly irritating to the tubules of the kidney. In canned fish the prolonged cooking transforms the smaller bones, which are rich in phosphorus, into gelatin.

Clinically, fish is found to contain valuable nutritional sub-
ances, while many of the factors known to be unsatisfactory are
ot present. It is for this reason that one usually advises that
ne child's animal protein food be equally divided between meat
nd fish.[2] Generally speaking, lean meat is more readily diges-
ble than fat meat. Fish and meat are usually assimilated to
ne same degree.

In the hinterland in many localities fresh fish cannot often be
isily obtained and salt fish has to be substituted. Unfortu-
ately fish preserved in salt becomes very hard and should be
oaked in water for several hours before using. Incidentally,
sh may be used in many instances as a substitute in the pres-
nce of animal protein allergies, these latter often resulting from
herited diatheses.

Fish does not appease the child's appetite to the same extent
does meat, nor does it produce the same amount of energy.
his very fact, however, makes fish the ideal protein food for
rvous, irritable children, especially those who suffer from an
tremely active metabolism rate. Sometimes it is advisable to
d bread, butter, and potatoes in order to supply the energy
hich is lessened by the use of fish. In the average healthy child,
th meat and fish proteins may be added advantageously to an
herwise balanced ration.[20]

IODINE DEFICIENCY IN THE DIET

Many observers have noted the absence of goitre and of glandu-
dysfunction in general among the inhabitants of the sea-
ard and among those living on islands some distance from the
inland. Two of the chief characteristics of sea food are its
line content and its generous supply of other inorganic salts.
is source of the mineral salts is furnished by tiny algae, a
m of plant life found in sea water. Thus the fish which feed
on the algae are able to supply abundant salts to be used in
balancing of metabolism.

Goitre, with its various manifestations, is by no means to be
ributed solely to a lack of fish food in the diet. The condition
often brought about by a scarcity of minerals in certain plant
ds which are normally present in the soil. Probably both
ple and exophthalmic goitre are related basically to iodine
vation.[23]

odine is unquestionably one of the most essential elements
health, growth, and development. It is to be found in
ny foods. As the spray of sea water rises in the air, the wind

carries it inland, to be deposited eventually on the subsoil, thereby benefiting plant life and, indirectly, animals far from the seacoast as well. In remote regions where goitres abound iodine may be supplied by giving one part of sodium or potassium iodide to 5,000 parts of table salt. Unfortunately many manufacturers of table salt today put out a product that has been overrefined and, in a sense, denatured.

In the nutrition of both young and older children, sea food in general has proven to be very satisfactory. Though we believe fish to be easier to digest, meat, especially when properly cooked, is usually more thoroughly masticated. At the same time it may be said that, in cooking, fish retains more important food factors than does meat. The average edible fish is estimated to contain, per 100 grams, the following percentages:—0.109 gram of calcium, 0.133 gram of magnesium, 1.671 grams of potassium, 0.373 gram of sodium, 1.119 grams of sulphur, and 0.0055 gram of iron. The same amount of meat would contain approximately 0.058 gram of calcium, 0.118 gram of magnesium, 1.694 grams of potassium, 0.421 gram of sodium, 1.078 grams of phosphorus, 0.0378 gram of chlorine, 1.146 grams of sulphur, and 0.0150 gram of iron. The substitution of fish for meat is seen to be fully commensurate with biologic values.[7]

Fish, if attractively prepared, is well liked by the average child. It makes a most satisfactory item in the diet. While small fish live largely on the algae and on other forms of organic nitrogen, the larger consume the smaller fish in addition to the plant foods to be found in the seawater. That nitrogen is found in various forms in fish is a firmly established fact.[24] On the whole, it is probable that the higher water and lower fat content of fish makes less work for the stomach to perform in digestion.

A brief statement should be made regarding the cooking of fish. Drying or cooking in too high temperatures decreases the vitamin content, although the other minerals are not necessarily changed. Especially when it is being prepared for children, boiling is considered an excellent method, since it effectively guards against furunculosis, worms, and perhaps fish tuberculosis. In the eggs of fish the phosphorus protein, ichthulin, is found in the ovovitellin. The fat of the spawn, such as roe and caviar, are rich in lecithins and cholesterin in amounts of from 4.05 to 14.0 percent. Vitamins A, B, and C, as well as sulphur and phosphorus, are found in large quantities.

The sight, taste, and sea smell of crabs, oysters, clams, shrimp, and lobsters whet the appetite of children and may be given advantageously, as they have the same composition as has the

esh of fish.[21] These crustaceans are literally mines of minerals oating in the water, for within their structures copper, manmese, and zinc are present in abundance.[25] These salts are great importance in nutritional anemia and allied conditions. very was able to find copper in the cells of sixteen different arine animals, the average amount being 0.497 mgs. per kiloam. Copper in combination with the proteins unites with ygen to form that nutritive complex, oxyhemocyanin. In the arine animal, copper acts as an oxygen carrier much as does on in the human organism.[26]

Beginning in late infancy, oysters and clams may be safely ded to the diet. Later, boiled fish, such as halibut and cod, ay be used, and about the fifth year, other varieties of fish and ultry may be employed for supplying proteins and minerals. ter on the heavier meats may be added.

One finds that nutrient percentages in the crustaceans differ t only in the several varieties but in different parts of the me species. For instance, the oyster contains more copper than es the lobster, while the stomach and thorax of the latter are her in this mineral than are its other organs, with the possible ception of the liver. The crab possesses more copper and zinc an does the lobster. According to Langworthy, the composin of the oyster is as follows:—

	Percent
Water	88.3
Nitrogenous substances	6.1
Fat	1.4
Carbohydrates	3.3
Salts	1.9

The observant physician is fully aware of the essential nutrie characteristics of copper, manganese, zinc, and other minerals the metabolism of children. Thus it would seem that the rine foods in the diet should be able to supply in part at least minerals which have been eliminated from the highly milled l demineralized cereal products in use today.[25]

EGGS

There is often a misguided inclination on the part of some icians to overvalue the position which eggs hold in child rition. As a matter of fact, eggs may prove a delusion and a re, particularly when used in the presence of protein sensition. Inherited dysfunctions particularly have been ignored

all too frequently in the past, and the malnourished child has been given eggs along with a limited few of other corrective foods. Older physicians may remember without pride the days when they prescribed quantities of eggs for the little tuberculosis patient and very little of anything else. To offset those experiences, however, we recall with real satisfaction at a later period an impending appendectomy that was halted by proving the condition to be one of egg poisoning.

Although eggs are mentioned collectively, no two of them give precisely the same analytical composition. In one respect though, eggs may be said to resemble children, in that they depend for their characteristics on heredity, race, environment, etc. That differences in them exist can be readily appreciated.[2]

THE COMPOSITION OF EGGS

In general, the nutritive value of the egg is high, so that it is of importance in the balancing of metabolism, except in certain allergic children. According to Koenig, the yolk consists of potassium, sodium, lime, manganese, oxide of iron, phosphoric acid, and fluorine.

Roettger lists the following composition:—

1	Water	51.8	Per	Cent
	(Vitellin)	15.8	"	"
2	Proteids; Nuclein	1.5	"	"
3	Fats (palmitin, stearin, olein)	20.3	"	"
4	(Glycerin, phosphoric acid)	1.2	"	"
	(Cholesterin)	0.4	"	"
	(Lecithin)	7.2	"	"
5	Cererbrin	0.3	"	"
6	Coloring matter	0.5	"	"
7	Mineral matter	1.0	"	"

The tables of Bridges give the following figures for the edible organic nutrients and fuel value of eggs:—

Item	Size of Portion	Carbohydrates	Percentage Value of Portion		
			Protein	Fat	Calories
Eggs, whole.......	50 grams	—	13.4	10.5	75
Eggs, whites......	35 grams	—	12.3	0.2	20
Eggs, yolks........	15 grams	—	15.7	33.3	55

Naturally there is a great difference between the eggs of dif-rent species of fowl; for instance, between those of the domes-cated hen and the wild duck. The nutrients of an egg almost rrespond to 42 grams of meat and to 150 grams of milk. If ere is no gastro-intestinal dysfunction for egg sensitization, gs are usually easy of digestion. Egg albumin is not pure, but made up of four albuminoid and mucoid bodies, chief of hich are ovalbumin and a trace of carbohydrate and ovoglobu-n and still another substance which is similar to fibrinogen. nhappily the white of the egg also contains sulphur ions, which nd to cause putrefactive disturbances. In the yolk, fat is minant, consisting mainly of vitellin, nucleoproteids, leci-ins, glycero-phosphates, and cerebrin. The vitellin splits up o albumin and lecithin, and the nucleo proteid divides itself o albumin and paranuclein, the importance of which lies in e fact that it has no xanthic bases and, according to Fauvel, es not form any uric acid. The fat consists of oleins, margarine, olesterin, and lecithin, the latter being found in large amounts. Eggs are valuable because they are readily digested in the in-tines, 95 to 97 percent of their fat being absorbed in this nner. Also there is usually less chance of fermentation from eir ingestion than from the use of meat. If eggs are eaten in cess, however, as is so often the case, lecithin accumulates, using a reflex irritation to the central nervous system, as well reducing the metabolic exchange which lowers the nitrogenous efficient.[2] Sherman estimates the edible portion of the hen's ; to contain about 0.00303 percent of iron.[7]

Eggs are known to be rich in vitamins A and B, but whether not they contain vitamin C, appears to be questionable. The n gold color of the yolk, so attractive to the eye, is largely pendent on the green forage of the hens and the lutein is gely enriched by a corn, grass, and worm ration. In winter eggs may be rendered more nutritious than at any other e of the year by feeding germinated grain to the hens.

Too long cooking or a prolonged stay in storage either weak-or destroys the vitamin content; but if the eggs are frozen nediately after they are laid, the vitamins are retained. In e of contrary opinion, hard cooked eggs are easier of diges-n and of assimilation than are soft cooked. Where long rneys are contemplated and the food must be carried, it is e to drop fresh eggs into boiling water for five seconds and n preserve them in a cool place, or, if this is impossible, drop m in a solution of sodium salicylate.[21]

DIGESTIBILITY OF THE ALBUMIN OR WHITE OF EGG

The white of egg possesses a high rate of digestibility and is an important item in the child's diet. Rose and MacLeod, in a series of experiments on human subjects, have given as many as ten to twelve raw egg whites as a part of a simple mixed diet. They found the average coefficient of digestibility for the protein of the whole ration to be 82 percent, of which the whites of the eggs alone provided 60 percent. With the eggs cooked, but with the ration otherwise the same, the coefficient proved to be 86 percent, of which 82 percent came from the eggs alone. The digestibility range for the cooked whites of the eggs and for those that were well beaten was practically the same. The value of measured amounts of egg whites in the nutrition of unsusceptible children is beyond question. Care should be taken to give the child only as much egg white as he can easily digest, absorb, and metabolize.[27]

ANTI-BACTERIAL ACTIVITY OF EGG WHITE

It may not be generally known that certain foods other than fruits carry with them bacteriologic properties. Egg white, when raw and sterile, possesses marked anti-bacterial properties for certain bacteria, but not for others. Among these latter are included the bacillus typhosus, bacillus coli, the v-cholera, and the bacillus proteus, all of which are unaffected by even undiluted egg white. On the other hand, the bacillus subtilis, the staphylococcus albus, and the streptococcus haemolyticus are definitely inhibited in dilutions of from one to eight egg whites, and are killed by stronger elements contained in one or two undiluted egg whites.[28]

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CHAPTER 11

MILK AND MILK PRODUCTS

Milk is not only a protein food of great worth; it is a completely harmonized biologic food blend of all nutrients. In the human, the first fluid secreted by the mammary gland after delivery is colostrum, which in its composition is markedly different from the secretion that follows. It is richer in albumin, in the globulin fractions of the protein, and in salt. It possesses many cells which contain nuclear material and which are frequently spoken of as milk corpuscles.

In the colostrum of milk drawn within the first few days after parturition, many elements are found. The colostrum cells, consisting of a number of small and large fat globules, are held together by a hyalin tissue or membrane. In freshly drawn colostrum these corpuscles exhibit amoeboid movements similar to the white corpuscles of the blood.[1] The fat of colostrum has a higher melting point and contains more cholesterol and lecithin than the subsequent milk. It protects the young of higher and lower mammals against specific pathologic organisms, a fact shown clinically in the milk of a young and healthy mother. In a week or so, the mammary gland secretion loses its characteristic colostrum properties and assumes those of normal milk.

The milk used for human consumption may come from the cow, sheep, goat, mare, or camel. In America and England, with the rise of woman's independence and her illusive ideas of sex equality, except among recently arrived foreign-born women, the cow is rapidly becoming the only source of lacteal nutrition for babies.

Milk is a highly complex metabolic product and is more complex in the mammary gland of the woman than in that of the cow, since her diet includes a carnivorous portion. In the woman are also found the vagaries of sex-passion, affection, and other mental conditions which affect the composition of her milk. Therefore, perhaps chemically, but never biologically, can these two varieties be compared and approximated. In cow's milk one finds protein, fat, sugar, and inorganic salts in the following proportions in relation to the weight of the milk:—

	Percentage
Protein	2.0 to 5.0
Fat	2.0 " 8.0
Sugar	3.5 " 7.0
Ash	0.63 " 0.84

The protein is composed largely of casein and lactalbumin, while the butter fat contains mainly fatty acids, such as butyric, caproin, oleic, palmitic, and stearic. Lactose is its sugar, and the ash is composed of several salts, calcium and phosphorus being conspicuously present. As the blood is the common carrier for most of the materials utilized in all forms of metabolism, it is the source of the milk solids. These precursors of milk solids are found by comparing the composition of the blood upon entering the mammary gland with that upon leaving it. This is naturally a subject of vital interest in relation to the artificial feeding of infants.

Kaufmann and Magna have shown, in a series of experiments, that the blood entering the mammary gland vein contains about twenty percent more dextrose than that coming from it. It is also reasonable to suppose that the lactose or milk sugar is manufactured from the dextrose or blood sugar. Incidentally, Blatterwick and Meigs have employed similar procedures to indicate the origin of the fat in cows' milk. They believe that the blood entering the udder carries more phosphatid but less inorganic phosphate than that leaving it. They draw the conclusion that in the matter of the butter fat, the mammary gland takes phosphatid from the blood, converts it into fat, and returns it as inorganic phosphorus, the excess phosphorus being derived from the breaking down of the phosphatid. Gary, following the same order of approach, shows that the blood entering the udder contains more amino-nitrogen than the blood coming from it, and unhesitatingly draws the conclusion that the proteins of milk are derived from the amino-acids of the blood. In studying milk secretion in physiologic terms, we deal with five large groups of metabolic products:—

	Percentage average
Water	87.0
Sugar	5.0
Butter fat	4.0
Protein	3.0
Ash	0.75

These percentages have often proven stumbling blocks to the

tyro physician in his work on infant food modifications.[2] Considering these constituents, one may say that cows' milk consists of substances which are partly in solution and partly in suspension; namely, milk sugar, casein, peptones, lactochrome, saline ingredients, minute quantities of substances dissolved in water, also milk fat, apparently emulsified, and a portion of the casein in the form of extremely fine granules.

Good milk contains probably from two to three and one half million globules in every cubic millimeter. One frequently notices a most amazing paradox, for freshly drawn milk turns blue litmus paper slightly red, and red litmus, blue, due to the presence of the phosphates of the alkali metals and to the carbon dioxide constantly being developed. The milk turns gradually to acid by the aid of bacteria, these acids being lactic and acetic. Cows' milk, then, stands between that of the human, or alkaline, and that of the carnivora, or acid product.

The amount of the solid matter of cows' milk varies within considerable limits, because of the health, the feed, and the environment of the cow. The proteins in milk are casein, lactoalbumin, nuclein, albumin, and serum albumin.

The relative amounts of the *mineral constituents* in milk are:[1]

Potassium oxide	18.82
Sodium oxide	11.58
Calcium oxide	22.97
Ferric oxide	0.06
Chlorine	16.23
Magnesium oxide	3.31
Phosphoric pentoxide	27.03

The amount of iron averages from 0.0002 to 0.0003 percent, and the copper only 0.000015 percent. Fresh milk has a peculiar, faintly sweet odor. Lactic acid is present, increasing in amount as the milk stands. Citric acid is another constituent.[3]

The probable composition of human milk is as follows:—[4]

	Percentage
Fat	3.36
Lactose	6.5
Proteins combined with calcium	1.5
Calcium chloride	0.059
Mono-potassium phosphate	0.069
Sodium citrate	0.055
Potassium citrate	0.103
Mono-magnesium phosphate	0.027

Lusk gives the percentage composition and percentage distribution and absorption of calories of cows' milk, as compared with that of the human, five and one half months after parturition; as follows:—

COMPOSITION

	Cow		Human	
Protein	3.41	3.2	1.0	1.52
Fat	3.65	3.9	3.0	3.28
Milk Sugar	4.81	5.1	6.4	6.5

DISTRIBUTION OF CALORIES

	Cow	Human
Protein	21.3	7.4
Fat	49.8	43.9
Milk Sugar	28.9	48.7

ABSORPTION OF CALORIES

Human milk	91.6 to 94.0
Diluted cows' milk	90.7
Diluted cows' milk plus milk sugar	92.2
Same given to stunted infant	87.1
Cows' milk given to an adult	89.8

Based on calories, the above chart shows great differences of composition. If, however, clinical results are not based upon calories alone but on environmental factors, such as the quantity of food material, the digestibility and metabolism of varied food products, and the use of additional food principles not necessarily of high caloric value, the conclusions indicate that cows' milk cannot be compared with human milk.

Another distinction between cows' and human milk is the small amount of extractive nitrogen contained in the former, while in the latter there may be 18 to 20 percent. Such an extractive contains a large amount of carbon.[4]

Cows' milk contains a larger percentage of protein than does the human product, and forms firm, cloudy masses in the stomach, while woman's milk, on the contrary, produces fine soft curds.[5]

The composition of cows' milk and of human milk differs also in other respects. The protein of cows' milk, or casein, is about 80 percent, and albumin about 20 percent. Human milk contains 40 percent casein and 60 percent albumin. Bechhold suggests that this variation has much to do with their different

AVERAGE COMPOSITION OF HEALTHY COWS' MILK[1]

Constituent	Parts Percent by Weight	
Milk-fat		
Butyrin	0.15	
Caproin	0.14	
Caprylin	0.02	
Caprin	0.07	
Laurin	0.29	
Myristicin	0.79	
Palmitin	1.00	
Stearin	0.07	
Olein	1.37	3.90
Casein		3.00
Albumen		0.40
Milk-sugar		4.75
Ash derived from the following salts, percentage composition according to Soldner.		
Sodium chloride	10.62	
Potassium chloride	9.16	
Mono-pot. phosphate	12.77	
Di-pot. phosphate	9.22	
Pot. Citrate	5.47	
Di-mag. phosphate	3.71	
Magnes. citrate	4.05	
Di-calcium citrate	7.42	
Tri-calcium phosphate	8.90	
Calcium citrate	23.55	
Lime combined with proteins	5.13	0.75
Water		87.20

reactions toward coagulation by acids and rennet, for the albuminates form unreversible colloids that protect against the reaction upon the casein. Porcher and Grollman have shown that the reaction is further complicated by the relative and absolute amount of the phosphates. While the composition of mother's milk depends also, to a great extent, upon the age of the mother; for the younger the mother, the better the milk; the perversity of the modern young woman detracts from lactation. Under our observation at the present time, is an infant three months old, the offspring of a young, healthy mother of 22 years with normally excellent milk. She lives on a well-cultivated, fertile farm, and with an abundance of vegetables, fruits, and milk around her, but she persists in eating a maximum of meat, mostly fried pork.[6]

HEREDITY AND LACTATION

Heredity surely does govern the variation in the metabolic activity of the mammary glands, at least potentially, in both the higher and lower mammalia, as expressed in quality and quantity, and in the percentages of milk constituents. Genetic observations largely limit themselves to two major phases of this problem:—(1) the quantity, or interaction of the many variables in producing small or large yields of milk, and (2) the butter fat percentage found in it. Unfortunately there exists rather meager information on other milk constituents, such as lactose, protein, and ash. Physicians of bygone generations knew that the metabolic activity of the mammary gland changes remarkably with age, nutrition, and certain forms of physical and mental stimuli. Breeders tell us that a cow of two years gives a relatively small amount of milk, at three years this amount is increased, and the maximum output is reached between the ages of six and ten years, after which time the production diminishes.

Many pediatricians favor a particular breed of cattle, since the milk from different breeds shows not only differences in quantity but in the percentages of constituents as well. This definitely indicates that these characteristics are influenced by heredity. Hence it is plainly indicated that cows should be bred according to quality and not number, a matter which has not in general been carefully considered.

As a matter of fact, geneticists interested in cattle breeding are deeply concerned with the breeding and cross-breeding of highly developed strains in their search for perfect cattle. The clinician is likewise interested in this question of cattle breeding, but from a quite different standpoint. He wants to know the percentages of milk constituents and their values in connection with infant food modifications. Gowen enlightens us from his experiments with the mating of three groups of cattle. He found that the Holstein-Friesian breed represented a high milk yield but a low butter fat percentage. The second group of Jersey and Guernsey cattle represented a medium milk yield and a high butter fat percentage, while the third group of Aberdeen-Angus cattle gave a lower milk and butter fat yield, which corresponded somewhat to the Jersey group. His work also included a few Ayrshire animals of medium milk yield and butter fat percentage, which seemed to be between the Holstein-Friesian and Aberdeen-Angus groups. Thus we observe the decided differences in yield between breeds.

Ellinger, too, has published an analysis of breeding experiments. His conclusions indicated the inheritance of a multiple factor. In his experience, the high milk yield of certain cows seemed to show a tendency for the milk production of the first generation of cross breeds to be increased slightly. Does this indicate, then, that the factors for a high milk yield are dominant in heredity? Is it possible that similar conditions exist in the nursing mother?

Strange though it seems, these observers believed that a distinct physiologic mechanism existed by which a cow was able to concentrate the butter fat in her milk. Even stranger still, they found wide differences among groups as to the part inheritance apparently played in controlling the cow's ability to concentrate on milk secretion.

If the production of butter fat is influenced by heredity, then inheritance must play a role in the variation of the other constituents. We believe that it does. The metabolic rates of Holstein-Friesian and Guernsey cattle differ with regard to their ability to synthesize the proteins of milk. Yapp has shown that for the milk of the Holstein-Friesians in his herd the protein content was 3.1 percent, whereas for the milk of the Guernseys it was 3.9 percent. The first generation of offspring which resulted from the crossing of these two breeds yielded milk with an average protein content of 3.4 percent, an intermediate yield between the two parental breeds. Results demonstrated the fact that the concentration of proteins within the milk is an inherited characteristic in which apparently the parents play an equal part. We had been in a quandary as to whether or not the lactose content of the milk was dependent upon inheritance, and these experiments showed a lactose content the source of which was essentially inherited. Results showed, too, that the ash content followed that of the other constituents in the matter of inheritance characteristics. It is of interest to note that lactation and milk nutrient processes may appear not only as dominants but also as recessives in inheritance, characters often related to atavism. It has been found that the milk production varies from one lactation period to another, this being true in the cow even as it is in the woman.[2]

HUMAN MILK

Human milk contains, in the aggregate, milk, fat, butyrin, milk sugar, casein, albumin, peptones, coloring matter, and mineral substances. Normal milk viewed under the microscope presents,

for the most part, a number of fat globules floating in a clear fluid. The globules of human milk measure in diameter from 0.002 to 0.005 m.m., those of the cow from 0.000062 to 0.00039 inches. The fat globules are of two types, fluid and solid.[1]

Clinically speaking, we have obtained the best results in our work on wet-nursing by adjusting the woman's animal protein intake to the age of the infant. There is a strong tendency for the young mother to follow the same diet both before and after pregnancy. The younger the infant, the less coarse meat and eggs and the more milk, sea food, vegetables, salads, fruits, cheese, and certain nuts, if desired, should be eaten by the mother. Milk products, fruits, vegetables, etc., are excellent lactagogues. In the later months of infancy, a larger protein percentage may be advised, although even at this time the quantity of meat and eggs suggested is dependent upon the quantity which can be readily metabolized. Even the milk of a healthy woman changes from time to time, due perhaps to seasonal changes, perhaps to the fodder of cows, or to milk from a different species of cow. Nature tends to self-adjustment, and there is in the organism of the infant a special adaptation for food from its own mother. These conditions may change, however, when affected by environmental relationships affecting the mother. Fortunately, there is also a certain organic food adaptation, even in infants fed artificially with cows' milk, which seems to adjust itself to certain percentages for infant food modifications. However, an exact and corresponding measurement of food principles on a diet of cows' milk which is as well balanced as that found in the healthy mother is impossible. For example, we have found that the rennin of the stomach has seemed to follow adaptive changes in the digestion of casein. Other secretions, such as juices, etc., may lend themselves to a similar adaptability.[4]

Theodore Roosevelt, in a speech delivered many years ago, made the remark that race suicide was steadily increasing in the United States. Birth restriction began among the intelligentsia, but of late all classes from the highest to the lowest have fallen under its spell. Some years ago, we voiced our sentiments in, *The Passing of the Nursing Mother,* and while we have not changed our views since then, it is possible that we have become slightly more tolerant. Wet-nursing follows the same decadent course as does the birth rate.

From a soap-box orator, the other evening, we heard a discourse on wet-nursing as against the artificial feeding of infants. The orator pointed out that the milk of a cow was from a differ-

ent species of animal, that it was an unnatural product in consequence, and that the milk of the infant's own mother was the only natural nutrition.[7] He was right. The life of the cow does not parallel that of the woman; the former being entirely herbivorous, the latter carnivorous and herbivorous. The metabolic activities of the cow arise from physical and physiologic conditions, those of the woman from physical, physiologic and psychic sources. Chemically, their milk may be compared to some extent, but psychologically, never. In addition to nutrition, all the events of a woman's life enter into her milk production and into the process of lactation.

It is entirely unjust, however, to make a blanket statement that all women of today do not want to nurse their infants. Young mothers may be able and willing to nurse their babies in the summer but may be unable to do so during the winter. During the winter months of our temperate zone, when the sun's rays are indirect and weak, the mother often prefers to remain indoors; and as a consequence, her own nutrition and her milk suffer correspondingly. Evidences of lack of the ultra-violet rays are seen as malnutrition in the infant, which is often the early sign of rickets. It has been established that by exposure to sunlight, or to the ultra-violet rays in artificial irradiation, animals and infants may be protected from rickets. Scientists are working on the theory that this anti-scorbutic protective quality can be transmitted through the mother's milk to the young. As the natural sources of ultra-violet light are deficient in the winter, an artificial substitute must be provided. Such a one is the quartz lamp.

Modern science is bringing the time near when the natural and artificial irradiation of the cow will be more closely studied. This affects indirectly the anti-rachitic value of her milk, which is dependent not only upon her diet but on the degree of exposure to which she is subjected.[8]

Normally the cow probably reacts with a slight erythema to rays of wave-length shorter than 313 mm., and as these rays penetrate less than a millimeter into its toughened skin, no injury is produced and its metabolism is benefited.

Visible radiation penetrates deeply enough to produce a widespread capillary dilatation in the sensitized child, which may end in death; but who has ever heard of a cow dying under the same circumstances? [9]

The anti-scorbutic power of healthy mother's milk is so lasting that breast milk dried by the Just-Hatmaker roller process, while

retaining about 80 percent of its anti-scorbutic value when first prepared, is still able to contain about 40 percent of its original value after "aging" for a period of two years.[8]

AGENCIES AFFECTING NATURAL MILK

There is no doubt that the controversy between the advocates of certified raw milk and those of pasteurized or heated milk has proved stimulating, particularly in regard to the effect of heat on the chemical and physical properties of the numerous salts of milk. Not only are these salts necessary to the formation of bone and teeth but they are of vital importance in the activities of cell metabolism; they are activators, in fact, of the metabolic rate and of growth impulse. Some observers claim that the heating of milk causes some of the soluble compounds containing calcium and phosphorus to become insoluble and be precipitated; others deny that these changes take place. Undoubtedly much of this wide divergence of opinion lies in the lack of uniformity of test methods. Some investigators have used whole, others skimmed milk. The age of the milk, too, is an important factor, for older milk has a higher acid content because of bacterial action.[10]

In the treatment of milk by heat, the actual process, the period of heating, and the degree of heat used are of scientific importance and clinical interest. Daniels and Stearns noticed that young rats fed on milk that had been subjected to long heat treatments, such as evaporated milk, condensed milk, or milk pasteurized by the hold process, failed to grow normally. The stunting appeared to be proportional to the length of the time of heating rather than to the degree of heat employed. Animals fed on milk pasteurized by the "hold" or long process attained only about half their normal growth. On the short, or "flash" method, they grew normally.

These failures may be attributed to the fact that the calcium salts are at least partly thrown out of solution and that during the heating they adhere to the sides of the vessel, a point noted especially in the case of evaporated milk. It seems probable that these slight losses in the calcium content of cows' milk brought about during the heat treatments may have considerable influence on the nutritive upbuilding of infants and children, particularly on the former, since their calcium requirements are relatively higher. Soldner pointed out that the lime salts in heated milk are useless for rennet coagulation and unsuitable for absorption. Phosphorus retention in the case of the "hold

and flash" methods was found to be fairly consistent with the calcium retention and was greater during the boiled milk feedings. This retention may have been due to a metabolic adjustment rather than to a greater absorption.[11]

LOSS OF NUTRIENTS IN HEAT-TREATED MILK

Through experimentation, much progress has been made in determining the degree of heat which preserves or destroys vitamin activity in milk. Along these lines, however, there remains much that is obscure. The alteration of the casein and of the water-soluble vitamin B, or the anti-neuritic vitamin, has, in the eyes of the vitamin minded, been the prolific source of dysfunction in the child. In their experiments, McCollom and Davis fed rations in which the sole source of the water-soluble vitamin was super-heated whey (15 pounds pressure for one hour). In some cases they used the water-alcohol extract of wheat embryo likewise treated. In neither instance was there evidence that the vitamin had been destroyed. When, however, skim milk powder was used that had been long heated in a double boiler or had been for one hour in an autoclave at a pressure of 15 pounds, the growth was not comparable to that obtained when using the powder unheated. The heated milk powder also lost its potency as supplementary material for rations consisting of polished rice, salts, and butter fat; all of which require both protein and water-soluble food accessories to make them support growth.

It is of interest to note that the addition of ten percent of unheated casein to a ration consisting of superheated milk powder stimulated growth. Some writers believe that the heating of casein for one hour in an autoclave at 15 pounds pressure destroys its biologic value as a complete protein. Hogan, on the other hand, believes that high temperatures affect the vitamins rather than the proteins in milk. He found that rations including superheated casein and egg white as the essential parts of the protein requirement produced growth similar to that secured by other rations containing unheated proteins. For example, when corn mixtures were used which furnished the vitamins superheated, it was proven that before the addition of these proteins growth was less marked than on similar rations unheated.

Are we to consider milk as a sufficient anti-polyneuritic agent? Gibson and Concepcion fed fowls on diets of polished rice to which milk was added. Some were given the rice and 100 cc. of raw milk, the others received an equal amount of rice and autoclaved milk. The results indicated that the milk had little

protective action against polyneuritis, for the birds receiving the additional milk developed polyneuritis in about the same time as did those fed on the polished rice mixture. The autoclaved milk, however, did not appear to precipitate the onset of the neuritic symptoms. When a considerably larger amount of milk (200 cc.), either raw or autoclaved, was fed, neither group developed neuritis or evidence of degenerative changes in the peripheral nerves. Certainly from these results it would appear that the antineuritic vitamin was not materially affected by the high temperatures (two hours at 125 degrees C.). The scientists found that the growth curves of rats fed on pasteurized milk were somewhat similar to those of animals which received milk which had been slowly heated to the boiling point. They, however, grew at about half the usual rate and never attained the normal size for adult animals.

Experiments of interest to the pediatrician were made with unsweetened evaporated milk. The results were even more surprising, for one group of animals made almost no growth gains and died after a few weeks. Two other groups showed slightly better results. The animals gained weight slowly and survived for longer periods. Eventually, however, they died in a miserable condition, showing rough coats and extreme emaciation. The somewhat better results obtained from groups 2 and 3 may have been due to the fact that the animals were two weeks older.

It was found that animals fed on sweetened condensed milk showed a better growth than those fed on milk which had long heat treatments. The results, in fact, almost equalled those in normal animals. It seems safe to conclude that experiments with long heat treatments of milk show that the calcium salts are rendered insoluble to a greater or less degree, depending upon the length of heating. It is probable, also, that some of the salts cling to the side of the vessel and some separate out with standing.[12]

Bell claimed that when fresh skim milk was heated to various temperatures the calcium and phosphorus underwent a loss in solubility due to the heating, and that the amount of this loss depended upon the temperature to which the milk was heated. He concluded that definite measurable amounts of calcium and phosphorus were removed from solution in milk heated to 170° F. or above.[10]

CLINICAL OBSERVATIONS

Just as the radio enthusiast reaches for distant stations when he might be enjoying the programs nearer home, many pediatri-

cians, possibly dissatisfied with raw milk, with pasteurization, or else seeking new worlds to conquer, experiment with evaporated milk or other adaptations.

A comparison of evaporated milk with the pasteurized product as a source of calcium, phosphorus, and nitrogen might be in order. Washburn and Jones, working with young pigs, found that raw milk gave a very slightly better storage of protein than did evaporated milk; namely, 118 calories and 108 calories respectively. This was decidedly better than that which occurred in the case of sweetened condensed milk—59 calories. The breaking strength of a pig's femur was slightly greater on raw milk, being 297 pounds, as opposed to 263 pounds on evaporated milk and 200 pounds on condensed milk. Magee and Harvey, also carrying out experiments on two pigs, obtained poorer retention of calcium, phosphorus, and nitrogen on the pasteurized product than on fresh or sour milk.

Daniels and Loughlin showed a satisfactory growth in young rats fed on quickly boiled milk or sweetened condensed milk, but not in rats fed on slowly pasteurized or evaporated milk. Daniels and Stearns observed better gains in weight on the quickly boiled than on the pasteurized milk slowly heated, as well as a better retention of calcium and phosphorus.

An experiment made by them on children may be of greater significance. They made observations on four normal children and on three adults. The children came from the vicinity of the Chicago stockyards. In experiment A, there were two girls, aged eight and twelve years, and two women. The younger girl was of stocky build, weighed 22.7 kilos and was nearly up to the normal standard for her age. The other girl was slender, weighed 29.3 kilos, was small for her age and underweight. Their previous diets had been low in calcium. In experiment B, two boys, aged three and four years, and two adults, were used. The three year old lad had previously received a diet low in calcium and had had plenty of sleep. The four year old boy had had a good diet but insufficient sleep, and his general habits were irregular. It was found that the 825 grams of milk taken by the older children supplied 90 percent of the calcium of their diets, 65 percent of their phosphorus and 40 percent of their nitrogen. In the case of the younger children, taking 810 grams of milk, the corresponding percentages were even higher. The older children were fed evaporated milk first, the younger children, pasteurized milk.

CALCIUM METABOLISM

The results of these experiments showed that all children ingested generous quantities of calcium in every case, up to one gram daily. This is in accordance with the observations of Sherman and Hawley. The lowest retention per day was 0.11 gram, the highest, 0164 gram, the older children retaining the greater amount.

PHOSPHORUS METABOLISM

The intake of phosphorus amounted approximately to one gram daily. The retention was higher when evaporated milk was used. The differences varied between 0.08 of a gram and 0.18 of a gram daily. This leads one to believe that evaporated milk is a liberal source of phosphorus.

NITROGEN METABOLISM

The daily intake of protein averaged two grams per kilo. per day for each child. One child showed a slightly higher retention with pasteurized than with the evaporated milk.

The results in the adults afforded no definite conclusion. In the children, all balances were positive. For calcium, they ranged from 0.11 to 0.64 grams daily, for phosphorus, from 0.11 to 0.33, and for nitrogen from 1.18 to 2.21. The children given evaporated milk showed a higher phosphorus retention in all four cases. For nitrogen and calcium, the higher retention averaged three out of four. In conclusion, it appeared that evaporated milk proved in general a somewhat more satisfactory source of calcium, phosphorus, and nitrogen than did the pasteurized.[13]

Evaporated milk has certain characteristics which correspond to those of fresh cows' milk. Its sugar is unchanged by heating; the fat is even more finely divided, and consequently more digestible. The protein is so altered that when the milk is curdled by rennin or citrus fruits the resultant curds are extremely fine, as in breast milk. The heating process partially denatures the albumin and casein, lending itself readily to anaphylaxis, however, as is the case at times with cows' milk.[14]

PREVENTION OF SOMATIC NUTRITIONAL DISEASE

There is no denying that the proper pasteurization of milk has prevented many bacterial diseases, with the exception of

he generating spores such as those of anthrax. In 1907, Rosenau abulated in detail some 317 cases of typhoid fever, 51 of iphtheria, 125 of scarlet fever; all these diseases having been ransmitted by infected raw milk. Those figures applied to an arlier day, but even now milk may be an infecting agent; not nly the raw product but that which has been pasteurized may rove dangerous if improperly handled. Medical literature ecords fifteen or more instances of typhoid fever having been raced to oysters. Many products are subjected to unclean andling, but the results do not usually prove as disastrous as n the case of milk.[15]

CONDITIONS AFFECTING MOTHER'S MILK

Human milk, then, is dependent upon many circumstances for ts quality—upon heredity, proper nutrition, and favorable sychic and physical stimuli. The ancestral potentialities of dequate lactation in women are often interrupted or smothered hrough the machination of wrong environmental forces. Analyes of human milk, therefore, show many discrepancies, for nother's milk is very variable, and because of these changes no ne examination represents the average secretion. In the soalled civilized life of today, a woman, because of emotions roused by a disordered nervous system, cannot produce a highrade product. Meggenhofen gives the composition of woman's nilk practically uninfluenced by emotions as follows:—

Constituent	*Percentage*
Milk fat	2.90
Casein	2.40
Albumen	20.57
Albuminoid precipitated by gallic acid	0.10
Ash	0.16
Water	88.00

Vogel gives the following analysis derived from milk of a voman suffering from hysteria:—

Milk fat	0.514
Casein	5.000
Sugar	3.492
Ash	1.010
Water	89.984
Specific gravity	1.032

J. F. Simon examined the milk of a woman in passion. The nfant after having been at breast had convulsions and diarrhoea.

The milk itself had an acid and peculiar odor, and after standing it developed hydrogen sulphide. In other words, this milk had already begun to undergo lactic acid and putrefactive changes in the breast itself. Such conditions, and others of a local origin, interfere with the healthy action of the milk-producing cells. We have repeatedly noted this unpleasant odor in a breast about to become barren from an emotional outburst.[1]

PASTEURIZED MILK AND CERTIFIED GRADE "A" RAW MILK

One must be indeed courageous to attempt to take part in a discussion of the merits of certified raw milk as against those of pasteurized milk. Opponents of either product refuse to be convinced. Boldly, however, we take our stand behind the virtues of certified raw milk, in spite of criticism from many quarters. It cannot be gainsaid that when clean, raw milk is not procurable, the heating of milk is justified. Though coming from a different species of animal, cow's milk, properly handled and properly modified, offers better health and a more substantial lease on life than does the milk from the breasts of a poorly nourished, sickly, overworked, and worried woman. The infant's organism, as has been stated, seems to have the ability of adapting itself to the milk of the cow. Clean, fresh cows' milk from the udder of a tuberculin-tested and otherwise healthy animal is one of nature's most perfect biologic products from the standpoint of food principles alone. It is complete, since in quality, if not in quantity, all the essentials for the building of muscle, bone, and general body structure are present. In addition, it contains certain vitamins, often unrecognized, which regulate growth and nutrition.

There are those who consider that the heating of milk removes all possibility of dangerous microorganisms. However, while pasteurization or other heating methods minimize some injurious effects, other and even greater evils are apparently increased. While one must freely admit that pasteurization is a most valuable means of protection against infections of typhoid fever, tuberculosis, cholera, or other milk-borne diseases, this form of processing does not necessarily afford protection against the invasion of the intestinal tract by pathologic bacterial flora. It is true that there are many aerobic bacteria in milk; notably the streptococci, micrococci, and other forms, which probably cease to grow in temperatures near or at nine degrees centigrade. Very likely these are killed readily by heat and leave no spores. It

is assumed that the majority of bacteria cease to be active at a temperature of four degrees Centigrade. Undoubtedly the heating of milk to 70 degrees C. for 20 minutes kills practically all the non-spore-forming bacteria. If heated at a temperature of 120 degrees C. for two hours, or 130 degrees C. for 30 minutes, all bacterial life is killed. According to Duclaux, heating beyond the 70 degree point produces a cooked taste.[1]

Those medical crusaders who in some communities have stood with their backs to the wall against pasteurization are heartened by the renewed interest awakened through research and clinical experience in the comparison of the two types. On the whole, very little has been done along scientific lines in biologically contrasting the certified raw milk and the pasteurized product. Lewis has provided charts showing the increased growth rate of infants fed on certified raw milk rather than on any form of heated milk. The difference is marked, especially during the period from birth to three months of age. It has been observed, too, that gastro-intestinal disturbances of infants fed on the raw product were less in number and less severe. The author's figure on the average bacterial count for the raw certified milk was 3,500 per cubic centimeter as the highest amount found, and from 350 to 400 per cubic centimeter as the lowest figures. The count for pasteurized milk ranged from 10,000 to 30,000 per cubic centimeter. On rechecking, this count was found to be even higher.

It has been claimed that the number of bacteria present up to 20,000 or 30,000 is immaterial as long as no pathogenic microorganisms are present. We think it is safe to assume, however, that a low bacterial count is presumptive evidence of the careful handling of the raw milk. Richards compared the average increase in bacteria occurring in a number of samples of both raw and pasteurized milk and found that the bacteria multiplied four times faster in the latter than in the raw milk. These figures were taken after the milk had been allowed to stand at ordinary ice-box temperature.

Klein objected to pasteurization because of the physical and chemical changes produced in the milk by heating, these changes becoming greater with longer heating and higher temperatures. Heating undoubtedly alters all the constituents of milk. The albumin is coagulated, the fat globules coalesced, some salts precipitated, the lactose caramelized, and the taste and odor changed. The sugar is decomposed at 120 degrees C., and certain undefined acids are formed.[1]

THE DECOMPOSITION OF MILK

In the decomposition of milk, the constituents are acted upon by different bacteria; some act on the sugar, some affect the proteins. If milk is allowed to stand in a warm place it becomes sour, a change due, no doubt, to the formation of lactic acid by bacteria. According to Thorner, the milk coagulates when warmed if the lactic acid content has reached 0.207 percent. The milk sugar is not only converted to lactic acid, but in addition certain amounts of carbon dioxide, alcohol, and butyric acid are given off. Alcoholic fermentation under ordinary conditions takes place only to a slight extent. With the introduction of the right microorganism, however, nearly all the sugar may be converted.

Milk sometimes develops a marked alkaline reaction; it becomes bitter through the formation of butyric acid, a product of the butyric bacillus and others. Many bacteria, both aerobic and anaerobic, may decompose the proteids of milk. Some of these organisms seem to act in a similar manner to pepsin and trypsin, producing peptone, leucin, and butyric acid. At times too, bacteria may color milk red or yellow, when it assumes a ropy character.[1]

INFANT'S GROWTH AND RETENTION OF CALCIUM PHOSPHORUS AND NITROGEN WHEN FED EVAPORATED MILK

Evaporated milk, preferably unsweetened, is now largely employed in pediatric practice, because of its easy digestibility. Concerning this, Jeans and Stearns have added valuable information. Nine healthy male infants were fed a mixture of equal parts of evaporated milk and twelve percent of corn syrup acidified with lactic acid. Orange juice, cod liver oil, egg yolk, fruits, and vegetables in addition were fed at suitable ages. The infants were observed from 18 to 48 weeks. Their growth in length and weight was excellent and exceeded the required standard. Except in the early weeks when clinical evidences of moderate overfeeding were present, the retention of nitrogen, calcium, and phosphorus was high and was approximately the same as the results obtained from using the undiluted, acidified fresh milk which had been fed to a group previously studied. The high retention of nitrogen, high excretion of creatinin, and good physical progress were considered evidences of good muscular

growth. The high retention of calcium and phosphorus, early carpal ossification, rapid growth in body length, and the absence of clinical or chemical evidence or rickets were considered further evidences of good bone growth. From the observations it was concluded that evaporated milk, when used with dietary supplements, was a good food for infants. From the standpoint of promoting good growth and high retention of nitrogen, calcium, and phosphorus, evaporated milk seems to compare favorably with fresh milk, when used with the addition of other foods.[15]

VITAMIN A IN EVAPORATED MILK

In spite of an opinion held by some that, with the possible exception of vitamins A and C, certain heat-treated milks, when subjected to proper processing, retain their vitamin nutrients, observations show this to be contrary to facts. One observer experimented on rats, feeding a vitamin A-free, irradiated basal ration, the so-called curative technique being used. Evaporated milks made by the vacuum and aeration methods were fed at various levels in direct comparison with the raw milk from which they were made. The conclusion drawn was that evaporated milk made by the vacuum process had lost some nutrient value and that this loss, which did not appear to be unduly great, was probably because of the destruction of vitamin A. It would appear that the aeration and sterilization of the milk increased this destructive effect to some extent.[16]

DRY MILK

One may safely conclude that if raw milk is not handled properly at its source and during transportation it may easily be subjected to harmful influences. On the other hand, evaporated and dry milk are not imperilled by similar conditions. This makes it easy to understand why today there are so many advocates of both evaporated and dry milk. Indeed, these products do retain most of the nutrients and characteristics of the raw product.

Even those whose preference is for modified grade A raw milk find instances where the use of the evaporated or dry product may be used to advantage. These processed forms of milk are sometimes employed to supplement raw or pasteurized milk feedings. Moreover, if the source of the raw product is questionable, the use of the processed milks will assure safety. One may easily conceive of circumstances which prohibit the raising of

healthy cows, such as desert wastes; and also communities where fodder cannot be grown successfully, for example, the far north. There are cases, Hirschsprung's disease, for example, in which a gross dysfunction prohibits the feeding of normal cows' milk. In spite of personal opinion as to relative merit, neither raw nor pasteurized milk can be standardized as completely as can the evaporated or dry product.

A good biologic test of a high class milk is its ability to aid in reproduction. Sapplee and Dow discovered that milk powder containing twelve percent of fat, packed and held in hermetically sealed containers for nearly two years, did not permit of reproduction in white rats when fed in quantities varying from 11.7 to 35 percent of the ration. This milk powder and fat mixture while packed and sealed contained the ordinary atmospheric air. When the same powder was stored in de-oxygenated air for the same period, it allowed of normal reproduction and rearing of young when fed in quantities varying from 23.3 to 35 percent of the ration. Even in smaller quantities, reproduction was possible, but the rearing of the young was interfered with. Another sample, held in air as was the first, but for a period of seven months, permitted reproduction and successful rearing of the young when fed as 41.7 percent of the ration.

Evaporated and dry milk, although processed, are therefore biologically closer to the natural product than many of the other processed mixtures. While our aim has been to remain as close to nature as possible in the matter of food products, circumstances sometimes necessitate certain synthesized forms. Many organic dysfunctions indicate that the use of top milk, predigested milk formulae, acid milk, condensed milk, lactic acid milk, as well as other forms, are more suitable in many cases than is the raw product.

There are two general methods in use at present for the preparation of dry milk. In one, whole pasteurized milk is sprayed into a chamber through which a stream of air heated to 180° F. is passed. This removes the moisture and dries the milk. As occasion warrants, this process may be applied to skimmed milk, protein milk, and acid milk. The second method is one which allows fresh milk to flow in a thin layer over revolving steam-heated drums from which the dried flakes are scraped. About half the fat is removed from the milk. The high temperature to which these products are subjected destroys pathogenic bacteria. It is found, therefore, that dried milk rarely contains pathogenic microorganisms. Incidentally, the heating process so

alters the casein that the curds formed are finer than those from fresh raw cows' milk.[14]

THE APPARENT DIGESTIBILITY OF FRESH WHOLE MILK AND OF POWDERED WHOLE MILK

Before deserting raw milk in favor of the processed varieties, it might be well to discuss some of the phases of experimentation as well as some of the conclusions drawn by several noted authorities. In the normal process of digestion the food is first subjected to enzymic action in an acid medium. Later the resulting digestive products are acted upon by a different set of enzymes in a neutral medium. It is difficult to reproduce these conditions in experiments by the means available; that is, artificial digestive fluids, the employment of stomach fistulae, and the use of human subjects from whom the stomach contents are removed by means of the stomach pump. Experiments of this sort yield valuable information, but they do not present a complete and reliable picture of the normal digestive processes in their entirety, nor are they as logical or biologic as the clinical observations made by the intelligent observer.

For example, the variation between the results of the extensive experiments of Wallen, Laurence, and Koch with evaporated milk and with raw milk carried out in vitro, and the results, recently reported by Nevens and Shaw, of experiments with animals, further confirm our stand as to the value of raw milk in the nutrition of infants and children. In substantiation, we quote experiments of Wasileff of Petersburg with healthy young people whose ages ranged from eighteen to twenty-three years.

He found that the proteins of raw milk were more completely digested than those of cooked milk. Also there was found a larger quantity of volatile fatty acids in the excreta after drinking cooked milk than after the ingestion of the raw product, which leads one to the conclusion that the process of cooking lowered the digestibility of the fat. Raudnitz claimed similar results.

The conclusions of investigators show a lack of uniformity which can be accounted for probably by diversified conditions. Fleischman and Morgen found that the longer the period of heating milk above a temperature of 85° C., the less digestible the protein became. Baginsky reported that in completely sterilized milk the casein was less readily precipitated by rennin, and the digestibility in gastric juice was lower than in raw milk. Somerville cites thirty pancreatic digestion experiments in which

the protein in milk made from the powdered form was more completely digested than the protein in raw milk. Stassano and Talarico discovered that dry milk was more completely digested during tryptic digestion than raw milk. Grunner, Kurtenacher, and Berg believe that heating milk at 60° C. renders the lactalbumin less soluble and less digestible. Hess, Koch, and Sennewald state that boiling milk definitely reduces its soluble protein content but facilitates peptic digestion.[17]

IRRADIATION OF FOODS

It is very questionable at the present stage of scientific knowledge if irradiation of matured foodstuffs in general enhances their vitamin and other nutrient potencies. It is impossible to believe, for instance, that cereal products can be fortified by vitamin D through this method. Cereals are supposed to contain a decalcifying substance the effects of which are overcome by the addition of vitamin "D." However, at the present time no evidence of this toxic factor apparently has been shown to exist.[18]

Hume, Goldblatt, and others have shown that the development of growth-promoting properties can be induced in vitro in oils and other substances by exposing them to the rays from a mercury lamp rich in ultra-violet rays. For normal growth the presence of fat-soluble vitamin "A" is necessary, but only a little of this is needed if irradiation takes place daily. Irradiated olive oil may possibly be used for promoting growth in children as a substitute in winter, when sunlight is scarce. It however, lacks radiant energy. Finally, even if radiant energy is administered daily by the sun or quartz lamp, and although it prolongs and stimulates growth, it cannot, without other factors, prolong life, unless at least two other elements are present, vitamins "A" and "D." [19]

In truth, of late there has been a great deal of experimentation on foods already matured, with the ultra-violet rays from the quartz lamp. Milk, fodder, and other foods, both for human and animal consumption, are being thoroughly tested as to their metabolic activities resulting from the rays. This activation may stimulate these foods in their growth impulse and other activities through its impression on the previtaminic factors. Whether the direct radiation of matured foods is entirely biological in character and whether it should be considered along with the indirect method on the animal or plant, remains to be seen. However, there is no denying the fact that growth promoting properties have been imparted to fats in dealing with the pro-

duction of an antirachitic quality. This antirachitic factor functions not only in the retention of calcium in rickets, but also is markedly beneficial in a child where rickets has not been demonstrated. This antirachitic factor, further, represents the organic agent which promotes normal anabolism, and may cure rickets, or it may promote growth, or again, it may prevent the excessive loss of lime from the child's body. Obviously the specific capacity in which it functions in the child depends upon the condition of that child in respect to age, to nutrition, and upon the composition of the ration furnished. It would seem that many of these activated products hold their potency over long periods, for Steenbock has found that activated olive oil, even after ten months in the dark, kept this potency unimpaired during that long period. On the other hand, he found that mineral oils and certain other oils, acid in reaction, such as cocoanut, corn, oleo, peanut, and cotton seed oil cannot be activated. It would seem, therefore, that one can turn his attention only in part away from nature's methods in establishing the biological activities in animal and plant metabolism, and that much more research and experimentation must take place before the impressiveness of direct activation on fully matured foodstuffs can be completely accepted.[19]

Milk, of all foods, probably lends itself best to irradiation. Of all the common foods available, milk is a most suitable carrier of vitamin "D," and this vitamin is concerned with the utilization of calcium and phosphorus, of which milk is an excellent source. For the same reason, milk products may be fortified in the same manner as milk. These products include evaporated milk, dried milk, dried skimmed milk, and flavored milk drinks prepared either from whole or from skimmed milk. However, unless the volume of milk in the prepared drink is at least 80 percent of the total volume, the fortification of milk with vitamin "D" probably cannot take place.[19]

During the past few years clinical and laboratory experiences have proved the value of irradiated milk in the prevention and cure of infantile rickets. Vitamin "D" is synthesized in inert material by an exposure to it of suitable radiant energy. While rickets is prevented by an adequately balanced diet containing vitamin "D" and harmonious environmental factors, under adverse conditions this vitamin may be partly or wholly absent in the ration. Since the development of rickets may take place in early infancy, and as milk is deprived of its full nutritional value by modification with water, irradiated milk, whether fluid or dry, proves a valuable asset. The technique used in milk irradia-

tion requires delicate and highly technical instruments, and the process cannot be accomplished unless irradiated milk producers have adequate means and skilled labor at their disposal. Suitable methods for the application of radiant energy and for its uniform distribution must be provided in order to maintain a proper intensity of the incident radiations. This involves a determination of the distance from the source of energy to the milk film and the use of reflectors of predetermined design and placement. Carbon arcs of the flaming arc type are commonly used. Large volumes of milk are exposed in the form of a working film which receives the rays at constantly changing angles of incidence varying from 0 to 90 degrees. The cycle of exposure to this range of impingement angles requires approximately but 0.3 seconds.[20] The thickness of the film is maintained at substantially 0.4 mm. and the time of exposure does not exceed 16 seconds. Since the radiations penetrate milk only to the depth of 0.1 mm. and since the activation of the provitamin depends upon direct exposure to irradiation, all particles of the milk must come in contact with the rays. A certain portion of the antirachitic wave lengths, as well as longer wave lengths, are reflected from the milk surface. The amount of such reflection is dependent on the character and intensity of the radiations and of the angle of incidence. The intensity of the radiations per unit of time is most important in determining the degree of antirachitic potency. A high intensity or a high rate of energy input per unit of time is necessary, not only for obtaining a satisfactory degree of potency, but also for the prevention of unfavorable secondary reactions.[20]

SANITATION IN MILK PRODUCTION

In certified raw and in pasteurized milk which has been collected and handled even under the most favorable circumstances, some bacteria probably will be present. Bacteria commonly found in milk grow and multiply most rapidly in temperatures of between eight to one hundred degrees Fahrenheit. At lower temperatures the growth correspondingly decreases. At seventy degrees the growth is rapid, at fifty, retarded and at forty, very slow. Many of the forms of bacteria found in milk produce no change in it, others may change the flavor without interfering with the appearance, and still others of the most common types cause marked variations in both flavor and appearance. In the former are found those bacteria which sour the milk by converting the sugar into lactic acid, and those other microorganisms

which form a sweet curd. Another type destroys the casein and albumin of the milk and causes putrefaction and bad odors. Incidentally, there are on record innumerable cases of infections with resulting deaths caused by divergent groups of milk borne microorganisms.

Those persons hostile to raw milk point with emphasis to the many changes which the raw milk product encounters before reaching the consumer. Foul sheds, dirty pails and cows, improper bedding and fodder, tardy transportation of the milk product to the ice house, badly refrigerated cars, careless handling of the milk at the receiving plant and en route to the consumer's home, are all depicted. Today, these objections are largely visionary, as the close inspection of farms and of milk plants under the jurisdiction of great milk companies will testify. Pasteurization is not always a mitigation of the evil, for dangers may lurk after and even during the heating process.[21] In passing, we may fittingly pause to review the modernistic experiences of Leslie A. Chambers and Newton Gaines of the University of Pennsylvania as to the destroying qualities of sound on bacteria. Their observations indicated that an intense 1.200-cycle note directed at a flowing stream of milk reduced its bacterial flora as effectively as pasteurization. These scientists used a modified form of electromagnetic oscillator originally designed for underwater signaling. The deadliness of sound, they explained, was seemingly twofold. It may shake the microorganisms apart or it may coagulate the protoplasm within the cell. Heating obviously has a similar effect. (Anon.)

PROBLEMS IN SANITATION

While problems of the present are not those of the past, one still finds faulty conditions. As the milk producing districts grow wider apart, milk must be transported to greater distances and handled in larger quantities. Certified Grade A raw milk must therefore be produced and handled properly to withstand these obstacles. There has sprung up, in late years, an increased demand for clean milk on the part of the consumer. Health authorities and the representative milk companies have done yeoman service in striving both for the production of nutritious and healthful milk and for its sanitary transportation.

When one realizes that the physician is dependent upon a high quality of milk, one can readily realize the load of responsibility placed upon the shoulders of large milk companies. Milk, for instance, from a cow with an infected udder, or milk

which is stringy or otherwise abnormal must be discarded as unfit for use.[22] In addition to the exacting methods used in the pasteurization of milk, it is very essential that strict attention be paid to its handling so as to prevent contamination subsequent to pasteurization. It is important that all utensils, bottles, etc., in which milk is placed be thoroughly sterilized and otherwise protected against contamination. In the handling of milk in smaller establishments there may be many sources of infection in the hand bottling and capping processes. There is also always the possibility that workers may be disease carriers.

Contamination of milk in restaurants and other eating places is apt to occur. The dipping of the milk, as sometimes takes place in rural communities, is not only a source of bacterial infection, but may also result in unequal distribution of the butter fat. Indeed, the control of cream pasteurization in a large city is more difficult than that of the milk supply. The demand for pasteurized cream fluctuates in many localities. At the end of the week there may be a greater demand than at the beginning. Also, variations in temperature influence this demand, as seen in hot and cold weather when the appetite for ice cream rises or falls. Then, too, the bacterial content of cream is often much higher than that of milk, and colon bacilli may be found in proportions of 0.001 to 0.01 cc.[23]

PASTEURIZATION AND BACTERIA

Observers may have noticed in some plants the presence of foam on the milk during the pasteurization process. They may have seen a considerable quantity of foam develop in the pasteurizer, particularly at certain seasons of the year, while at other times the amount might be negligible. Experience has shown that this foam is responsible for high bacterial counts, for ropiness, etc., which may later be discovered in the pasteurized milk. Foam is noticeable during what is termed the "holding period" and may vary in depth from perhaps half an inch to several inches. Workers have noticed that the bacterial count in the foam is considerably higher in every instance at the beginning than at the end of the holding period. Although the bacterial count of the milk decreases during this period, 66.7 percent of the foam samples gave a higher count after "holding" than before, and there is also a wide variation in the bacterial count of the samples of foam taken at different places in the same vat. It must be said, however, that these studies were of the bacterial count of milk and of the foam in a vat with the cover tightly

closed, as compared with that of milk pasteurized in a vat with the cover slightly raised or loosely fitting.

Convincing proofs have indicated that where the vats were not tightly closed or were slightly open the bacterial count of the foam increased to a decided degree during the holding period. Similar studies disclosed that where the covers were closed a perceptible decrease of bacteria was noted. Conclusions were formed that some plants were not effective in raising the foam to a satisfactory pasteurization temperature, or in always accomplishing as great a destruction of bacteria in the foam as in the milk. Pasteurized milk, it would seem, cannot be recommended as a completely sanitary substitute for raw milk, but pasteurization is a safeguard. However, if a certain milk is considered so dangerous or so impure that it cannot be given to children in the raw state, and we refer particularly to children suffering from minor or intermediate dysfunctions, it must be pasteurized or otherwise processed, if it is to be used at all. If pasteurization means only the temporizing with foul milk, one had best omit the process altogether.[24]

MILK FORMS AND BY-PRODUCTS

SKIM-MILK AND SEPARATED MILK

Skim-milk and separated milk have been used by pediatricians for a long time in making up formulae for the artificial feeding of infants. Circumstances dictate the methods employed in this separation. Skim-milk is milk skimmed by hand; separated milk is milk which has been "whirled" in a centrifugal apparatus; this latter process produces a far more perfect separation of the milk-fat. By the old method of setting in open pans, from 0.8 to 1.0 percent of milk-fat remained; by the modern centrifugal method, only from 0.1 to 0.5 percent of milk-fat is left. The composition of separated milk compared with the milk in its original state is well seen in the following analysis by W. Fleischmann:—

	Fresh Milk	*Cream*	*Separated Milk*
Fat................	3.64	67.63	0.46
Casein..............	2.73	1.17	2.88
Albumen............	0.68	0.25	0.49
Sugar..............	4.69	2.25	5.34
Ash................	0.71	0.12	0.72
Water..............	87.55	28.58	90.11
Total Solids.........	12.45	71.42	9.89
"Solids not Fat".....	8.81	3.79	9.43

CONDENSED MILK

This is prepared by concentrating whole or separated milk. The product may or may not contain added sugar, but when used, cane sugar is usually chosen. Small amounts of invert sugar may be present.

The schedule requires that all condensed milk shall contain not less than:—

	Milk-fat Percent	*Milk-solids Percent, Including Fat*
1. Full cream, unsweetened.........	9.0	31.0
2. Full cream, sweetened...........	9.0	31.0
3. Skimmed, unsweetened..........	.....	20.0
4. Skimmed, sweetened..........	.....	26 0

CONDENSED MILK FORMULAE: PRACTICAL PERCENTAGES

	Sweetened Milk				Unsweetened Milk		
	Full Cream		Skimmed		Full Cream		Skimmed
	1	2	3	4	5	6	7
Water...........	25.05	25.14	26.62	27.03	71.68	73.48	76.62
Milk-solids......	33.39	32.94	27.21	26.38	28.32	26.52	23.38
Fat.............	10.64	9.60	0.22	0.29	9.28	9.20	0.75
Lactose Hydrated	12.25	13.07	14.93	14.25	10.33	9.31	12.50
Proteins.........	8.57	8.41	9.61	9.53	7.06	6.25	8.35
Sucrose.........	41.56	41.92	46.17	46.59	....	....	....
Ash.............	1.93	1.86	2.45	2.31	1.65	1.74	1.78
Acidity.........	0.32	0.28	0.35	0.30	0.35	0.40	0.41

Sweetened milk depends for its keeping properties on the large proportion of cane sugar which it contains. Unsweetened milk depends for its preservation on sterilization.

DRIED MILK

Dried milk must contain the following percentage of milk-fat:—

DRIED MILK

Dried full cream milk	26
Dried three-quarter cream milk	20
Dried half cream milk	14
Dried quarter cream milk	8

CREAM

In composition, cream fairly agrees with ordinary milk, save that it contains a larger percentage of fat as well as a higher percentage of casein and albumen. The average composition of Devonshire cream is:—

	Percent
Milk fat	65.01
Casein	3.53
Albumen	0.52
Peptones	0.05
Lactochrome	Undetermined
Milk-sugar	1.72
Water	28.67
Ash	0.49
Chlorine in ash	0.01
Calcium phosphate	0.37

A milk-fat content under 25 percent does not constitute cream.

KOUMISS

Koumiss was originally made from mares' milk, but now cows' milk is used. One part of sour milk, containing lactic ferment, and a little sugar is added to ten parts of fresh milk. A chemical change takes place, or a partial decomposition, resulting in the development of lactic acid, carbon dioxide, and alcohol, with possibly the albuminoids changed into peptones. In variable quantities, the constituents are water, milk-sugar, lactic acid, casein, milk-fat, alcohol, carbonic acid, and ash.

BUTTERMILK

Buttermilk is the thin whey left from the butter-making process. It is a dilute, poor acid milk, not fat-free, and contains in addition

all the other constituents of milk. The lactic acid content increases as the buttermilk stands. It is composed of water, casein, fat, milk-sugar, lactic acid, and ash. *Butter* contains milk-fat, water, casein, milk-sugar and ash, the amounts of which are under Government regulation. The water content in this country is 16 percent, in Germany and Belgium, 18 percent.[1]

CHEESE

Cheese is one of the most important by-products of milk. It might reasonably be considered a milk solid. Cheese has been universally recognized as an excellent source of calcium in the children's diet, yet in the diet of the average American child it is unreasonably absent. This is not true of European countries. Unfortunately, some children dislike milk and others like it, but through an inherited digestive dysfunction sometimes cannot digest it without "sensitization," or allergic after-effects. In order to maintain the required calcium content of the body and for the metabolization of phosphorus, cheese may be safely advised. The calcium of cheese is as readily metabolized as that of raw milk. Like the proteins, there are many kinds of cheese, some easy and some hard to digest. Who would, for instance, add Dutch, Swiss, American, or Cheshire cheese to an infant's milk modification? Cream cheese, however, possesses great value in specific inherited dysfunctions and in other somatic digestive disturbances.

Some varieties of cheese are made with rennet, some with lactic acid. Obviously they contain different percentages of calcium. Blunt and Sumner found 0.71 percent in American Cheddar, 1.05 percent in Swiss, and cottage cheese (pot cheese) had 0.77 percent. These varieties make attractive calcium rations for older children.[25] Soft cheeses are made from whole milk or from milk and cream, while hard cheeses are made from whole or partially skimmed milk. In general, in making cheese, rennet is added to the milk; which causes the casein to split up into two compounds, one of which is soluble and allied to albumen; the other being insoluble in the presence of calcium phosphate, which carries down with it most of the milk-fat, as well as some of the milk sugar. The rennet brings about this change by the action of an enzyme, which acts only in an acid or neutral medium, and under an optimum temperature of about 41°C.[1]

MOUTH AFFECTIONS INFLUENCED BY CHEESE

There are a number of mouth and gum affections in infancy and childhood where milk and cheese, given in fitting proportions, have a palliative, remedial, and curative effect, particularly if correlated with the balancing of metabolism. Among such affections may be named herpes simplex, stomatitis, as especially observed in scurvy and pellagra, and catarrhal stomatitis occurring during dentition. We are tempted to say that more can be done during the pregnancy of the mother in connection with her ingestion of cheese to prevent minor malformations and early tooth decay in the expected infant than can be accomplished after birth. However, much can be done in the early months of infancy by adding cream cheese to the milk modification. Many individuals suffer from improperly developed teeth which, in reality, date from a mother's diet during pregnancy.

Many cases of difficult dentition are alleviated, at least, and the organic reflex symptoms of nervous children are lessened in their intensity by a higher ration of calcium and phosphorus in their food. Two symptoms most commonly seen are wakefulness at night and irritability during the day. There is a coexistent loss of appetite, perhaps a moderate salivary secretion, and a mild catarrhal stomatitis. Red and swollen jaws during the teething process are certainly benefited by an increase of calcium and phosphorus in the diet. As cheese and milk contain a large proportion of vitamin A in addition to these salts, their value is obvious. Incidentally one may add to the other disturbances acute simple pharyngitis, a form which is due to digestive disorders and which is benefited, if not cured, by the introduction of calcium and phosphorus into the diet.[26]

THE VITAMIN A CONTENT OF CHEESE ACCORDING TO RICE AND MUNSELL

Kind of Cheese	Approximate Units of Vitamin A		
	Per Ounce	Per Pound	Per 100 Calories
American	700	11,200	560
Cream	1.400	22,400	1,260
Cottage	30	480	95

CHEESE[14]

Item of Food	Average Portion: Grams	Average Portion: Measure	Carbohydrates: Nutritive Elements	Carbohydrates: Percentage Composition	Proteins: Nutritive Elements	Proteins: Percentage Composition	Fats: Nutritive Elements	Fats: Percentage Composition	Calories
American, pale....	20	1 inch cube	0.1	0.3	5.8	28.8	7.2	35.9	90
American, red.....	20	1 inch cube	—	—	6.0	29.6	7.6	38.3	95
Camembert........	30	1 ounce	—	—	6.3	21.0	6.5	21.7	85
Cheddar, grated....	25	¼ cup	1.0	4.1	7.0	27.7	9.2	36.8	155
Cottage (pot)......	50	3 tablespoons	2.2	4.3	10.5	20.9	0.5	1.0	55
Crown Brand cream	25	2 tablespoons	0.5	2.2	1.3	5.2	14.5	58.0	140
Full cream........	25	2 tablespoons	0.6	2.4	6.5	25.9	8.4	33.7	110
Liederkranz.......	30	1 ounce	—	—	4.8	16.3	7.9	26.4	95
Limburger.........	30	1 ounce	0.1	0.4	7.0	23.0	8.8	29.4	110
Neufchatel.......	30	1 ounce	0.4	1.5	5.6	18.7	8.9	27.4	100
Pineapple.........	30	1 ounce	0.8	2.6	8.9	29.9	11.6	38.9	150
Roquefort.........	30	1 ounce	0.5	1.8	6.8	22.6	8.8	29.5	115
Stilton...........	20	1 inch cube	—	—	4.8	23.9	7.8	38.9	90
Swiss (American)..	30	1 ounce	0.4	1.3	8.2	27.6	10.4	34.9	130

COMPOSITION OF CHEESE[1]

	Water	Ash	Fat	Protein	Fat on Dry Cheese
Cream Cheese...............	42.3	0.49	49.2	7.75	85.3
Lactic.....................	30.3	0.35	60.5	5.34	86.8
Pommel (English)...........	44.9	0.50	45.5	7.20	82.5
Whole Milk Cheeses					
Bondon..................	55.2	6.98	20.8	15.40	46.5
Brie....................	50.0	4.12	27.5	18.32	55.0
Camembert...............	49.3	4.40	22.5	20.10	44.4
Cheddar.................	30.5	4.10	30.7	30.20	44.4
Cheshire................	37.1	4.42	30.7	26.93	48.8
Gorgonzola..............	27.8	4.02	35.5	28.00	49.2
Neufchatel..............	37.8	3.4	41.3	23.60	66.5
Roquefort...............	36.8	5.39	30.6	25.25	48.4
Stilton.................	23.6	3.51	39.1	32.55	50.1
Skimmed-Milk Cheeses					
Dutch...................	41.3	7.10	22.8	28.25	38.8
Gloucester..............	25.2	4.80	25.8	30.05	34.5
Parmesan................	32.5	6.20	17.1	43.60	25.3

IRON IN CHEESE

In a table showing the total iron in typical food materials, cheese is quoted as containing 1.3 milligrams of iron per 100 grams of fresh substance, 5 milligrams of iron per 100 grams of protein, and 9 milligrams of iron per 3,000 calories. Cheese and milk contain some quantities of protein, phosphorus, and calcium, but cheese also contains magnesium, potassium, sodium, chlorine, and sulphur.[3]

THE COW

Some people seem to think that the cow is a magician, that she can spring from any scrub stock, can eat almost anything, and then can produce good, rich, wholesome milk. There are, however, as many aristocrats among cows as among humans, and the potentialities of inherited dysfunctions and the consequences of poor nutrition and faulty environment may be quite as disastrous in the cow as in the child. They may be even more so, for poor nutrition and unsuitable environmental factors harm the child alone, while corresponding conditions in the cow disarrange its own metabolism, thereby producing a milk poor in quality, often in quantity, inducing disastrous effects in the nutrition and growth of many infants and children.

BODY BUILD AND METABOLISM IN COWS

Van Norden always denied the importance of hereditary anomalies of metabolism. He stressed the importance of habits of living; those habits, for example, which favor obesity, from the quantity and quality of the food and from the inactivity of the body. The Eskimaux are fat, he said, because they eat fat foods, blubber, and oils, and they huddle in narrow spaces during the long dark winters, having little body movement. He made no mention, however, of those Eskimaux who, in spite of an active life during the summer, still remained corpulent.

Davenport avers that there are inherited anomalies of protoplasm. There are conditional habits of feeding and of choosing certain foods, as seen in infants, children, and cattle as well.

It is well known among breeders that cattle differ greatly in their capacity for fattening and in their growth impulse and metabolism rate. Compare the findings of biologists working on the lower animals. Do not the findings in animals stimulate

identical observations on children? Armaby and Fries, in 1911, devoted much time and labor to the study of the details of type, and their influences upon the fattening of cattle. They used a pure bred Aberdeen-Angus steer and a scrub steer of part Jersey stock for comparison. The former belongs to the easy-fattening race of cattle, the latter to the milk type.

During the experiments, which were continued for over two and one half years, and beginning when the animals were less than one year old, the steers were almost constantly under observation. They were fed alike on ordinary growth building rations. The digestibility of the total ration was determined at stated intervals, four tests being made of each animal in the respiration calorimeter to determine the percentage availability of the energy of the feeds consumed by each. The results proved interesting. The analysis of the feces and of the urine failed to show any difference in percentage digestibility of the food of the two animals, and the calorimeter tests likewise showed no difference in the proportion of the food energy which was being metabolized. Yet the two animals did not have the same metabolic rate, for in the scrub a larger proportion of the gain was made by protein than in the case of the beef steer, and conversely, the gain of the beef steer consisted to a greater extent of fat than in the case of the scrub. Reduced to a common weight, the energy requirement for the maintenance of the scrub steer was nearly 19 percent greater than that for the beef steer. Since the beef steer could eat more than the scrub, and tended to store up fat rather than protein, the greater tendency of the beef steer to fatten had a biochemical explanation. These results would seem to show a difference between the two varieties of cattle in the metabolic rate of the assimilated materials. Indeed, it is not hard to believe that steers of the beef and of the dairy types of cattle must metabolize their food quite differently, when one considers the marked difference in the milk production of the cows of the two types.

Furthermore, the cow of the highest dairy type was usually capable of producing 20 kilograms of milk containing 1.2 kilograms of butter in one day, or six percent.

The cow of the meat type, on the other hand, and of larger size, produced up to 30 kilograms of milk, and this contained perhaps 1.3 kilograms of butter fat per day, or only 4.3 percent. There must be, then, an internal biochemical difference as well as a difference in the feeding instinct, as suggested by Davenport. Such comparisons, were they applied to children, might show similarities, but along dissimilar lines. Certainly there is in

children as in cattle a relationship between the ingested food and physical activity, yet these two considerations are not the entire explanation, as is evident for instance, in obesity.[27]

OBSERVATIONS IN HUMANS

Gulick, a thin man, made experiments on himself and concluded that a person belonging to a difficult-fattening group shows a wasteful rate of oxidation when either under- or over-fed, but particularly in the latter case. Every physician at some time in his life has remarked upon some factor at work in certain children which causes the fuel food to be oxidized more freely, more quickly than in other children; some factor there must be in the chemistry of nutrition which has been potentially inherited along with the organism.[27]

INBREEDING IN CATTLE

Professor Leslie C. Dunn, in describing his studies of inbreeding in fowl, conducted over a period of years, stated that he had mated brothers and sisters together. The immediate results of this inbreeding produced invariably weak animals which lacked constitutional vigor. However, when two such inbred fowls were in turn mated, the resulting offspring possessed all the vigor of the original stock.

Bakewell, a stock breeder of the eighteenth century, made similar tests, and went further; for he mated parent with offspring and obtained improvements. It may be recalled that similar good results in human inbreeding have been previously quoted. The hybridization and inbreeding of cows certainly attract attention in the consideration of rich, nutritious, palatable milk.

Bos found after an extensive inbreeding of rats that a steady falling off in fertility took place, and that the general health was lowered during the first six generations of inbreeding. The material used was, however, a hybrid stock. Helen Dean King of the Wister Institute carried on extensive work with a large number of rats and her conclusions were contrary to those of Bos. Her original stock were four rather under-sized but, in other respects, normal albino Norway rats. The brothers and sisters were mated. For six generations no selective mating was practiced and many defects showed themselves. But after the sixth generation 20 females in every 1,000 were selected for superior qualities. From this stock, the result of inbreeding for

25 generations was very good; superior, indeed, in many respects to the original stock.

One may perhaps visualize identical conditions in milch cows, and establish reasons for the unusually poor and insufficient milk of some herds. Sewall Wright of the United States Department of Agriculture found that, in general, the mating of brother and sister resulted, as in the human family, in a steady loss of vigor and reproductiveness, and that prenatal and postnatal mortality was increased. A chat with a breeder of cattle might give valuable insight into the interesting results obtained, and one could compare them with one's own experience in children. Nine families, Wright continues, of those animals under observation seemed to remain fairly strong, while others declined so rapidly that to perpetuate them would have been out of the question. One stock with low vitality, but normal in body size, he believes may produce. Another stock might show undiminished vitality but a greatly reduced reproductivity and a diminished size.

Thus it might come about that even powerful and progressive milk companies, although insisting upon the proper feeding, housing, and handling of cows, might be robbed of nutritional milk through unwholesome inheritance characteristics of certain cattle.

D. F. Jones adds further enlightenment when he sizes up the whole situation in these words, "The only injury that can come from inbreeding results from the inheritance received." If, therefore, the animals possess many undesirable dominant and recessive characteristics, nothing is more positive than that inbreeding will bring them out. All that inbreeding does is to reveal that which was masked behind dominant characters. On the whole, inbreeding precedes a loss in size and vigor in both cows and children, although it varies in different strains and in different species. On the other hand, cross-breeding, which is essentially hybridization, may establish new races, new individuals, greater vigor and reproductivity, and in cows, a greater and better milk supply, for it is the result of favorable combinations of genetic factors of different strains.[28]

STOCK POISONING

Picture a fertile farm in a farming community and a mixed herd of Holsteins and Jerseys feeding in its meadows. Farm buildings are modern, the fodder, even that for winter, is excellent in quality and profuse in quantity. Modern methods are used in the care of the cows and in the handling of the milk.

From a select and mixed few of the high bred cows, the milk was kept for home consumption. The milk from one cow, a prize winner, of very high bred strain, was given exclusively to the little girl of the family, who was two years old. A few days before our visit, the child had complained of nausea and intense itching of the body surface and a petechial rash had appeared. The milk from the selected cow was distasteful and she had vomited it, as well as other food which she had ingested. Intermittently the child complained of headache and pain over the eyes, and her temperature rose slightly. Her general condition was excellent, and no specific cause was found for her symptoms. The milk possessed a distinct pungent odor and a most bitter and disagreeable taste. The milk used by the family, on the contrary, proved excellent, nutritious, and tasty.

On a close inspection of the feeding grounds we found a patch of small wild cherry trees in a remote corner. With their removal the child's symptoms disappeared.

Physicians may sometimes be deceived in like manner. A number of cases in our experience of milk idiosyncrasy and pseudo-sensitization were undeniably caused by milk rendered unpalatable by noxious weeds and unripened or decayed fruits in the cow's feed. Therefore, it seems wise, in certain cases of milk and cream distaste, to inquire first into the milk supply before attempting medical treatment, or even skin tests. It is a fairly common practice to praise the milk and milk products of a farming community, yet the cleanest, safest, purest, best inspected, transport-handled, and scientifically tested milk is that delivered by the powerful milk companies and communities.

A mixed milk from a mixed herd of divergent races and strains of cattle can be better standardized for food value than one from a small herd of a specific stock. Such a combination of different milks not only heightens its nutritional value but lessens the possibility of milk distaste, milk idiosyncrasy, and milk poisoning, as compared with the milk from a restricted herd of cows. In a few cases, one may discover in outlying districts very mild instances of malnutrition from stock poisoning. The stock, farmers say, seldom eat poisonous plants when good food is at hand, but at times certain animals prefer such unreasonable fodder, this preference later tending to become a habit. This habit seems to bear a resemblance to geophagia, or dirt eating in the child. If such stock can be driven to better feeding grounds, or if these unwholesome growths are exterminated, this habit may be obliterated.

In many instances also, a few children on farms have objected

to the smell and taste of milk from their own cows but have thrived on that from the cows of a neighboring territory. Stable smells, unpleasant odors from the bodies of the cow milker, from clothing such as boots, gloves, sweaters, and caps, may attach themselves to the milk.

Among many poisonous plants which affect cattle may be mentioned the larkspur, which often grows during the season of short feed or upon an overgrazed area, usually grass-starved by sheep. The roots of the water hemlock (circuta) may be picked up from a poor grazing field, and often with disastrous results. At times there may be milk poisoning from wild cherry, poison weeds, green rye, and green cow peas, and even cabbage and potatoes may affect the odor and flavor of milk. In the Carolinas it is said that cattle are poisoned by "stagger grass," but only in the spring. This lily grows luxuriantly at a time when there is but little grass, and the cattle eat it in place of something better.[29]

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CHAPTER 12

THE VEGETABLES

VEGETABLES may be classified botanically as follows:—

(1) the flower, such as the vegetables, cauliflower and broccoli;
(2) the roots, such as the sweet potato;
(3) the stem, such as celery;
(4) the leafy vegetables, as spinach;
(5) the fruits, such as the tomato;
(6) the seeds, of which peas are notable examples.

In general, vegetables contain water and carbohydrates in varying amounts, and protein and fats in smaller amounts, with mineral salts and vitamins in large proportion. Improper cooking often depletes the carbohydrates of about sixty percent of their food value and the loss of the mineral salts and vitamins may be considerable. Probably the best way to retain the nutritive qualities of vegetables is to bake or steam them. Some vegetables are best cooked in the skin, while others are nutritious only in the raw state.[1]

DIGESTIBILITY

Vegetables are important in the diet not only as an aid in the balancing of metabolism and in maintaining health, but also in replenishing nutrient deficiencies in inherited and somatic dysfunctions. In protein or carbohydrate sensitization, substitutes may be found in the vegetables for the protein or carbohydrate to which the child is hypersensitive. In certain disease conditions where a low caloric ration is advisable, vegetables are often indicated. In the diets of normal children, cooked as well as raw vegetables should be prescribed, and a proportionate amount of each should be served during the day. Incidentally, it is to be regretted that food fanatics have emphasized the illusion that raw vegetables are to be preferred over cooked vegetables or vice versa. Meat and vegetables undergo dissimilar processes in their preparation. The cooking of meat softens the connective tissue so that it is more easily acted upon by the gastric juices, and in the stomach of a healthy, active child a certain amount of meat is easily digested. In the cooking of vegetables the starch cells,

under the influence of heat, burst and permit the digestive juices to reach the contained starch. Unfortunately, the temperatures used in cooking them are often much too high. Many vegetables have their individual rate of digestibility, and a knowledge of these rates may prove of vital importance in specific cases of malnutrition or even in such cases of food sensitization.

For example, the white potato, whether boiled, creamed, mashed, or baked, leaves the stomach in a moderate period of time. Even potato salad and potato chips are digested with the same ease. Potato eaten with fresh butter leaves the stomach sooner than without the fat. Sweet potato is harder to digest than the white and may remain in the stomach for a long time. Cooked red beets and raw carrots are quickly evacuated, but cooked carrots remain in the stomach a little longer. Peas and string beans are easily digested, and so is cabbage, the latter still more readily if raw. Lettuce is also quickly digested, although any added fat salad dressing may halt a rapid departure from the stomach. Onions remain in the stomach longer than many of the other vegetables, while raw tomatoes and fresh young stewed corn pass on quickly, although the latter, in the case of a weak digestion, may not be completely digested en route. In brief, it may be said that vegetables which are low in vegetable protein, as are carrots, celery, tomatoes, cabbage, lettuce, and cucumbers, tend to leave the stomach rapidly, and they develop a moderately high, free acid. Vegetables rich in starch, such as the potato, show considerable starch disintegration before leaving the stomach. In these days of threatened food concentration in tablet form, it is well to consider what the physical state of the food means to biologic activities. Meat and vegetables are better digested when eaten in lumps; as are also both Swiss and American cheese. Milk, when drunk by the glass without being "soaked up" by other foods, rapidly forms smaller curds than when sipped during the meal, as it passes more rapidly on its journey.

Extreme caution is advised in prescribing vegetables in diarrhoea and in similar conditions. Not only are they not digested, but they may act as mechanical irritants in the digestive tract and thus augment the pathologic condition already existing.[2]

VEGETABLES AND METABOLISM BALANCE

The vegetables and allied agricultural products are a great aid in the balancing of nutrition. The demand for animal foods in any community is usually entirely out of all proportion to their utilization and they only aggravate the evils which concern the

preservation of health and the prevention and cure of disease. It is well known that herbivorous animals are less liable to nutritional anemia than are the carnivora, for they obtain their food from plant sources. Judging from the reports of missionaries and explorers, the inhabitants of tropical countries likewise obtain their nutrition from these sources. As the vegetables contain large amounts of inorganic salts, including iron, they not only aid in motivating metabolism but also in arresting anemia. They possess in addition a laxative action, so that toxins from animal food putrefaction may not only be neutralized but an existing intestinal residue may be expelled.[3]

COMPARISON OF A MEAT AND VEGETABLE DIET

While the eventual metabolization of meat and its products results in a sudden outpouring of energy, the ingestion of vegetables tends to release this energy at a slower rate. Meats are more catabolic in their nature than are vegetables and necessitate an excessive disintegration of nitrogenous molecules.

If meat is eaten by the growing child in excess, its nutritional value degenerates to a mere unbiologic stimulation of the nervous system with a resultant irritability. Not only do abnormal digestive and organic disturbances take place, but the mood of the child may change to one which the mother explains as cantankerous. Meat is partly a gastric food, while vegetables, on the other hand, are uninfluenced by the stomach juices, but gently stimulate the intestinal tract. A vegetable diet benefits the kidneys also, for its internal physiologic changes develop less toxic material to be eliminated. An ideal ration contains the carbohydrates as well, for they are savers of protein and cause less cellular catabolism than does meat alone. This rate of catabolism is highest with the protein ration, moderate with milk, and at a minimum with the vegetable diet. Fewer purin bodies are contained in vegetables and do not, as do the meats, excite an overactivity of the endocrines. The uric acid formed by vegetables is less toxic than that formed by the animal foods. Particularly is this true of the legumes. It must be borne in mind, however, that vegetable foods do not excite the digestive secretions as does meat, and that the vegetable nutrients encased within their cellular envelopes are often unattacked by these secretions.

This may happen to a child with an enfeebled digestive system or one with a gastro-intestinal dysfunction. Proper cooking and the straining of vegetables, especially the legumes, may overcome

the condition. In diarrhoea or in the case of an excitable peristalsis, vegetables should never be used, for other foods combined with them may be hurried along the intestinal canal without proper digestion and absorption. Vegetables compare well with the sea foods in that they are also mineral salt treasure houses, for their malates, oxalates, citrates, tartrates, and other nutrients are all necessary to keep the blood alkaline and to fight against the acidifying influences of meats, eggs, and other protein foods. They also exert a potent control on the acetone bodies, products of the fats, as well as on the urates, which are the products of defective metabolism.[4]

THE LEGUMES

In European countries, in Asia, and in the Far East, as well as among the Latin peoples on this side of the globe, the legumes form a rational addition to the diet and are considered an important food. Lentils, peas, beans, the soy bean, and the peanut are highly nitrogenous foods, even surpassing in this respect many kinds of meat, and they contain certain carbohydrates as well. Their nitrogen is found in the form of legumin, which is a kind of vegetable casein. This legumin is a mixture of the globulins, albuminoses, and proteoses. Many inorganic salts are contained in them, chiefly potash, lime, and phosphorus; the amount of the latter being exceeded only in meals. Besides these salts there is found nucleo-phosphoric acid and considerable sulphur. In excess, this sulphur causes flatulence, due to sulphurated hydrogen and to the microbic decomposition of the cellulose. In the bean one finds also an appreciable amount of oxalic acid and a high lecithin content. Properly cooked and carefully strained, the legumes easily displace the meat proteins in an enfeebled digestive system, in certain types of nutrient deficiencies, and inherited and somatic dysfunctions of uncertain nature, in their ease of digestion and absorption. A finely strained purée of lima beans or lentils may be wisely given in late infancy, and as a soup unstrained to older children. The vegetable proteins, as well as those of meat, eventually split up into uric acid. While beans admittedly contain much cellulose and sulphur, they do contain large quantities of phosphorus, magnesium, potash, sodium, lime, oxide of iron, sulphuric acid, salgulic acid, chlorine, and a purin base, which largely make up for the excess of cellulose and sulphur.

The soy bean, so highly esteemed in Far Eastern countries, is rich in nutrients, in fat, in albumen, in carbohydrate, in phos-

phorus, and lecithin. Indeed, in the high content of lecithin and phosphorus it surpasses all other foods. It is an elastic product, an edible oil, and a flour, and cheese may be made from it. The lowly peanut, which is not a nut but a vegetable, is high in fat, contains twenty-four percent of vegetable protein and seventeen percent of carbohydrate, but in the raw state is very difficult of digestion. As a nut butter, finely chopped or pulverized, peanuts are more easily digested and assimilated.[4]

THE LENTIL

Of all the legumes, the lentil has for us a particular attraction. It is a very important food, for it is easily digested, and contains less cellulose than do the other legumes. Its iron content is but slightly less than that of egg-yolk. As a purée, it may be given in late infancy, and the whole bean may be served as a thick soup or as a vegetable in later childhood. While this legume occupies an important place in the diet of Europeans and South Americans, in North America it is not given the position it deserves. Admittedly, the legumes, even the lentil, should not be the main source of protein in the diet, but should be supplementary. In animal food allergies and in nutrient deficiencies accompanied by an enfeebled digestive system, they often prove their importance. It is generally recognized that the presence in foodstuffs of certain amino-acids, whether of animal or vegetable origin, shows the food value of these particular protein foods. Among the outstanding amino-acids may be mentioned the hexone bases, arginine, legsine, histidine, and probably best of all, cystine.

Cystine should be differentiated from the others, in that it contains sulphur, which plays such an important part in oxidation and reduction in the living cell. The proteins of several legumes are nutritionally inadequate because of a deficiency of this amino-acid. Jones and Murphy found that albino rats made a very unsatisfactory growth when fed diets in which navy beans, lima beans, adsuki beans, and cow beans constituted the sole source of protein. Berczeller reported that in his experiment young rats lived but a short time on beans, longer on peas, and longest on lentils. While dried lentils contain but a small amount of the antiscorbutic vitamin, when germinated they form a valuable source of vitamin B. They also have a large content of vitamin A and are a better source of this vitamin than are most of the other seeds.[5] It may be of interest to mention the work of Chick and Hume, who showed that unsprouted beans did not contain the antiscorbutic vitamin, whereas if sprouting took

place, as well as cellular reproduction, an obvious abundance of it was produced.[6] A thick lentil soup emphatically supplies enough of vitamins A and B to children, and Jones and Murphy have demonstrated, in an experiment with rats, that only about two to five grams daily of the lentils were required to supply enough of these two vitamins.[5]

More detailed analyses of the outstanding legumes are appended. Koenig states the analysis of the *pea* as follows:—

Water	14.31	Percent
Nitrogenous substance	22.63	"
Fat	1.72	"
Nitrogenous free extractive		
Nitrogenous free extractive matter	53.24	"
Woody fibre	5.45	"
Ash	2.65	"

Lentils are highly nutritious. They contain fifty-nine percent legumin. Their composition is as follows:

Water	12.51	Percent
Nitrogenous substance	24.87	"
Fat	1.85	"
Carbohydrates	54.78	"
Woody fibre	3.58	"
Ash	2.47	"

According to Ritthausen, the legumin of the *kidney bean* has a composition different from that of other legumins.[7]

Water	13.60	Percent
Nitrogenous substance	23.12	"
Fat	2.28	"
Carbohydrates	53.63	"
Woody fibre	3.84	"
Ash	5.53	"

NUTRIENT PERCENTAGES OF FRESH VEGETABLES

While the vegetable proteins do not possess the same nutritious value as their animal prototypes, they should not be considered inferior to them in nutrition. In the Utopic dream of a completely balanced metabolism the vegetable proteins, the vitamins, and inorganic salts, components of the vegetables, form no small dependable part. The knowledge, not only of the digestibility, assimilability, and absorbability of vegetables, but also of their

nutrient values and caloric percentages, is very pertinent when, to establish a better nutrition, the latter essentials are compared with those of the animal foods, particularly meat, fish, and egg. The nutrient and caloric percentages of the most popular vegetables are as follows[4]:—

	Percent Protein	Percent Fat	Percent Carbohydrates	Caloric Value
Cabbage	1.6	0.3	5.6	143
Carrots	1.1	0.4	9.3	204
Cauliflower	1.8	0.5	4.7	130
Celery	1.1	0.1	33.0	84
Chard	3.2	0.6	5.0	173
Corn, green, canned, fresh, sweet	3.1	1.1	10.7	459
Dandelion green	2.4	1.0	10.6	277
Egg plant	1.2	0.3	5.2	126
Potato chips	6.7	39.8	46.7	2598
Pumpkins	1.0	0.1	5.2	117
Spinach	2.1	0.3	3.2	109
Squash	1.4	0.5	9.0	209
Tomatoes, fresh or canned	0.9	0.4	3.9	104
Turnips	1.3	0.2	8.1	178
Beans, lima, fresh	7.1	0.7	2.0	557
String beans	2.3	0.3	7.4	184
Baked beans	6.9	2.5	19.6	583
Red kidney beans, canned	7.0	0.2	18.5	471
Onions, fresh	1.6	0.3	9.9	220
Green peas	7.0	0.5	16.0	454
Dried peas	24.	6.	1.0	0

In spite of lampoonery and witticisms, spinach or dandelion greens are remarkable vegetables, not only as a valuable nutritional asset in the diet of older children but also in the feeding of infants. Spinach is particularly rich in both minerals and vitamins and ranks high in calcium content, but it must be admitted the latter is less soluble in spinach than in most other vegetables. Furthermore, spinach contains an unusually high percentage of oxalic acid, which, unlike many other organic acids of both fruits and vegetables, is apparently unoxidized in the child's body. Eaten in too large quantities or too often, its free or combined oxalates may at times interfere with the assimilation of other foods, and cases of oxalic poisoning by spinach have been reported. However, the importance of this article of diet is demonstrated by experiments made on seven healthy women to whom spinach was fed for six days as the only high

alcium food in a diet which included other commonly used oods. The amounts of spinach employed produced distinctly ositive calcium balances in six of the seven women and a alcium equilibrium in the seventh. In fact spinach furnished eventy percent of the calcium in an intake greater than the alculated requirement for maintenance. Besides furnishing nough calcium for direct metabolic activities, spinach tends to upply an ample amount for calcium storage.[8]

CALCIUM AND PHOSPHORUS IN VEGETABLES AND IN OTHER FOODS

Nature expresses her endorsement of certain nutrients, such as alcium and phosphorus, two of the most efficient inorganic salts, n that she richly endows many food products with them. Since t is apparent that a hastily chosen food supply may not always urnish the needed amounts of calcium and phosphorus, it ecomes important not only to choose foods with a liberal calcium

APPROXIMATE AMOUNTS OF CALCIUM IN FOOD MATERIALS

Foods	Calcium per 100 Grams Edible Substance	Calcium per 100 Grams Protein	Calcium per 3000 Calories
	grams	grams	grams
eef—all lean	0.007	0.03	0.18
ggs	0.067	0.5	1.35
gg yolk	0.137	0.9	1.1
ilk	0.120	3.7	5.2
heese	0.931	3.5	6.4
Vheat—entire grain	0.045	0.33	0.4
Vhite flour	0.020	0.18	0.18
ice—polished	0.009	0.06	0.04
atmeal	0.069	0.4	0.5
eans—dried	0.160	0.7	1.4
eets	0.029	1.9	1.9
abbage	0.045	2.8	4.3
otatoes	0.014	0.6	0.5
urnips	0.064	5.0	4.8
pples	0.007	1.9	0.36
ananas	0.009	7.7	0.27
ranges	0.045	5.7	2.6
runes—dried	0.054	2.6	0.5
lmonds	0.239	1.2	1.1
eanuts	0.071	0.3	0.4
Valnuts	0.089	0.5	0.4

and phosphorus content but to know in general the percentag of these salts contained in them. Foods vary in their calcium an phosphorus contents, whether expressed in percentages of th food material or in relation to its protein content or energ value. In America and in Europe the most practical means o insuring an abundance of calcium, particularly in the diet o infants and children, is by the free use of milk and cheese a foods. Incidentally, milk should never be given between meals a a beverage and should never be drained from a glass, but shoul be sipped throughout the meal and taken in combination wit other foods. These foods insure a good intake and storage o phosphorus as well as calcium, and are the vehicles for a favorabl ratio between calcium and phosphorus.[3] The demand of th infant's organism for these salts is even more enormous than th child's. Besides milk and cheese for calcium, spinach and carrot meet the phosphorus and calcium demand in boundless measure Now, while the clinical experience of Rose has shown that the cal-

APPROXIMATE AMOUNTS OF PHOSPHORUS IN FOOD MATERIALS[3]

Foods	Phosphorus 100 Grams Edible Substance	Phosphorus per 100 Grams Protein	Phosphorus per 300 Calories
	grams	grams	grams
Beef—all lean	0.218	0.96	5.2
Eggs	0.180	1.35	3.66
Egg yolk	0.524	2.73	3.54
Milk	0.093	2.82	4.02
Cheese	0.680	2.58	4.68
Wheat—entire grain	0.423	3.25	3.54
White flour	0.092	0.81	0.78
Rice—polished	0.096	1.19	0.81
Oatmeal	0.392	2.36	2.97
Beans	0.471	2.20	4.11
Beets	0.039	2.42	2.52
Carrots	0.046	4.17	3.03
Potatoes	0.058	2.60	2.07
Turnips	0.046	3.55	3.51
Apples	0.012	3.15	0.60
Bananas	0.031	2.35	0.93
Oranges	0.021	2.58	1.20
Prunes—dried	0.105	5.00	1.05
Almonds	0.465	2.25	2.16
Peanuts	0.399	1.55	2.19
Walnuts	0.357	1.96	1.53

ium of carrots is well borne by children, McClugage and Mendel ailed to arrive at the same conclusion when they fed carrots and pinach to dogs. They frankly concede, however, that the poor tilization of these vegetables may have resulted from their being ried before they were fed. Hart, Steenbock, and Hoppert have oncluded that the calcium of the green plant, and undoubtedly hey included the phosphorus also, is on the whole better assimi- ated in the raw than in the dried state. They feel that the vidence which they have accumulated showed that the calcium nd phosphorus of vegetables are in reality capable of sustaining ody maintenance in man.[9]

Charts and a descriptive tabulation of these salts contained in egetables as well as in many other foodstuffs follow.

THE MANGANESE CONTENT OF PLANT AND ANIMAL TISSUES

In singling out phosphorus and calcium as deficiency replenish- ng salts, one cannot forget another which is today arousing much peculation; namely, manganese. Many consider it of great vorth in infant nutrition, particularly when associated with iron, n the treatment of anemia and in some other forms of un- balanced metabolism. Scientists have collected valuable analyti- cal data on the mineral content of certain foods. They have given us valuable information on the minerals, sodium, potas- sium, calcium, magnesium, sulphur, phosphorus, chlorine, and ron, but a great deal of research is still to be done with such nineral salts as manganese, fluorine, bromine, silicon, boron, luminum, copper, arsenic, and zinc, as they occur in foodstuffs. If manganese is to occupy a major place in the nutrition of nfants and children, as now seems probable, it is well to investi- gate in what foods it is found and in what percentages. Man- ganese varies widely in many foods, from none in several species of fish to 0.02162 percent in northern grown lettuce. Tree fruits grown in temperate zones are usually low in this salt, but some tropical tree fruits contain a percentage of 0.00333, as seen in the banana, while the grapefruit lacks it entirely. Bush and vine foods may contain manganese to the extent of 0.00178 percent, roots and tubers 0.00184 percent, nuts 0.00186 percent, legumi- nous seeds 0.00200 percent, and leafy vegetables 0.00670 percent. Leafy vegetables also are generally high in many mineral ele- ments. There occur, however, wide variations in the manganese content of the leafy vegetables, of tree fruits, berries, roots, and tubers, and also of the soil in which they are grown.[10]

NUTRIENT VALUES OF DRIED AND CANNED VEGETABLES

In many localities far distant from markets, as in some parts o Canada and the United States, children are compelled, for a par of the year at least, to depend on dried rather than raw vegetable and on the legumes in particular. Their nutritional content i easily seen in the following tables.

DRIED LEGUMES[1]

	Grams	Household M	Carbon	Protein	Fat	Calories
Beans	75	⅓ cup	49.4	13.6	0.5	265
			64.9	18.1	1.5	
Navy beans	75	⅓ cup	44.7	16.9	1.4	270
			59.6	22.5	1.8	
Soy beans	100	½ cup	33.1	30.2	15.3	400
			33.1	30.2	15.3	
Raw lentils	25	2 tsp.	13.7	6.4	0.3	85
			54.7	25.7	1.0	
Cooked lentils	100	½ cup	28.0	12.0	4.5	205
			28.0	12.0	4.5	
Dried peas	100	⅓ cup	57.5	24.6	1.0	345
			57.5	24.6	1.0	

CANNED VEGETABLES

Canned vegetables have been in use for a number of years and the processes of preserving them have now become both an art and a science, for their nutrients are largely held intact. Many vegetables are put up specifically for children, and they have more nutritional value, processed as they are by modern methods, than as they are commonly prepared by the housewife and mother.[1]

VEGETABLE SOUPS

While bouillon soups in infant and child nutrition have been condemned by many as consisting of only flavored water and possessing no nutritional worth, it would be obviously unfair to make a blanket condemnation of all soups and to discriminate against them. The general custom in many communities of cooking vegetables in water and throwing away the water in which they were cooked deprives these food substances of their

vitamins and salts and leaves but a cellular mass, hard to digest and of little nutritional value. This rejected water should be either drunk or made into soup. Such soups as are made from this fluid-thin bouillon prove easily digestible and replenish in a moderate way mineral and vitamin deficiencies. Thick vegetable soups made from the whole vegetable are excellent in children's diets, while soups made from sieved and strained legumes, from the lima, soy, the lentil, from peas, and from the stems and roots of vegetables, are valuable sources of nourishment for both the infant and child.

FOOD PRINCIPLES IN LEAVES

Vegetables properly prepared, steamed to the right degree and no more, and certain raw foods are valuable sources of mineral salts and of vitamin supply. It may, however, be a surprise to many to learn that green leaves contain a vegetable protein as well.[2] The reason for our present rather meager knowledge of the protein constituents of living plants is due chiefly to the difficulties encountered in separating the contents of the cells from their enveloping walls. At present there is no satisfactory evidence of the nature of the compounds which contain a larger proportion of the nitrogen in the green leaves of any plant. The high grade physiologic function of the leaf justifies the expectation that it may contain certain constituents chemically unlike those found in other parts of the plant or in the cells of animal tissues. Chlorophyll may be mentioned in this respect. It is highly probable that the leaf is the seat of a protein synthesis, and it is already known to be that of a carbohydrate one. Those who profess to live chiefly on vegetables, fruits, and nuts seem to derive from them enough protein to cover their nutritional needs. Incidentally, the close relationship of the amino-acids to the carbohydrates and the recognized conversion of ketonic acids into amino-acids suggest clinical possibilities in certain dubious metabolic conditions occurring in children which deserve consideration. The protein of the leaf may represent the original protein source from which all other kinds of proteins are formed, either directly or indirectly. Investigations have proved that one fourth of the solids of the spinach leaf is protein and that one fourth of its total nitrogen belongs to non-protein substances which are soluble in water. The dry solids of the spinach leaf are much richer in protein than are any of the cereals or, in fact, some of the commercial protein concentrates such as bran, middlings, etc. The cells of leaves are physiologically among the

most active of those of all organisms, and the chemical constitution of their contents is much like that of the cells of active animal tissues. The larger proportion of water and of cell walls makes the leaf appear to be a relatively poorer source of true nutrients than it actually is. If one could separate the contents of the cell from these obstacles, a food product of great value could be obtained. Under experimentation, colloidal protein was found to have the properties of pure protein and contained from fifteen to twenty-five percent of nitrogen. As it yields purpurol, an equivalent to from two to five percent of pentose, this protein of the leaf may be seen to be a new type of a combination of protein with carbohydrate-containing groups. Colloidal protein is probably a mixture of several individual proteins which are the constituents of certain elements of the cell. Spinach leaves, when dried at low temperatures, yield the same nutritional value as when fresh, for drying seems to do them no harm.[11]

RAW VEGETABLES IN THE DIET

In speaking of the nutrients found in the leaves, stems, and roots of plants, it is important to discuss raw foods, as they so markedly influence nutrition in infancy and childhood. The omission of raw vegetables in the diet of children in some parts of Europe and America is very noticeable, and the ignorance shown of their importance is often extraordinary. Salads are often not made attractive to the child and consequently the habit of eating them is not inaugurated in early life. People of the present generation have seemingly traveled far afield since the time of their ancestors. In those days of more natural foods, men and women were apparently sturdier and more rugged. Today, with poorly selected and devitalized foods, with foods often overcooked and too soft for the proper use of teeth and of jaw muscles, many children start life in an unnatural way. One meal of the day should contain at least some roughage, not only for the vitamins and mineral salts contained in the raw foods, but as a natural eliminant. A concentrated, dry, solid meal is followed by a similar fluidless residue in the intestines. One more fluid in character is easily propelled along the digestive route by a stimulated peristalsis. A dry residue tends to remain lodged, constipation results, and intestinal toxins immediately form. Usually only simple methods need be used in avoiding constipation. Prior to the breakfast of old-fashioned long steamed cereals with cream, milk, brown sugar, and raw fruit, the child should drink a glassful or at least one half of a glassful of cool, not cold, water.

Preferably whole grained cereals should be used. The delicious cracked wheat cereal of other years, one of the most nutritious of all known cereals, should be reestablished. Raw fruits, as well as raw vegetables, form a natural roughage, and when possible should be given with their skins intact. Apples, pears, grapes, and plums may be mentioned in this particular; their vitamins lurk under the skins. Vegetable and fruit salads added to a balanced meal insure a soft, well-digested bowel residue, and a satisfactory stool. Vegetables, on account of their cellulose content, resist the action of the digestive ferments, but the cellulose is acted upon by the intestinal bacteria.

Cellulose absorbs the fluid of the meal, and under the influence of the intestinal bacteria fermentation ensues. This fermenting material mixed with the other products of digestion gives to the mass the proper bulk, but a soft consistency. Those vegetables which render excellent service in this respect, as they contain an abundance of cellulose, are spinach, turnips, beet tops, cabbage, cauliflower, brussels sprouts, lettuce, celery, peas, beans, etc. Among the fruits which cause a laxative action may be mentioned peaches, apples, pears, melons, and the berries.[2] Modern scientific nutritionists have given the subject of raw foods a great deal of attention and in food analyses have discovered the underlying reasons for their activities.

ANCIENT LAWS AND CUSTOMS

The prescribing of raw foods is not modern, indeed it is very ancient. Holy Writ advises the use of raw foods. Did not Daniel, many centuries ago, recommend that these foods be eaten with judgment and understanding? Does not the Divine Law imply the command, "Behold I have given you every herb having seed, to you it shall be for meat." Nor does it suggest the cooking of them. The foods allowed under this law did not include meat, eggs, cheese, milk, tea, or coffee.[12] Primitive man found little danger in the food he ate, for he alone obtained it and it passed through no other hands. In that olden period there was but little barter, food exchange, or cookery. Man fought for his food and for that of his family, and as it was the flowering period of the survival of the fittest, the stronger in consequence lived better than the weaker.[13] With the advance of so-called civilization, the eating of raw foods became confined to a few staple articles such as milk, iced foods, and certain crustaceans such as oysters, clams, and shell fish in general. Leafy vegetables such as lettuce, escarole, chard, watercress, and sorrel were also included, as were

the fruits, nuts, and fruit beverages. Today, the outlook for the admission of raw foods to the daily diet is more hopeful, and more foods are discovered to be fully digestible in their raw state, raw carrot for example.

Unfortunately, celery, lettuce, escarole, or other raw products often find limited place on the American table, and as parents eat them only occasionally, children, in sympathy with their elders, do not acquire the taste for them. Although not considered essential to the American dinner, no European table d'hote is complete without a salad of raw vegetables. Indeed many medieval methods of cooking foods and of preserving them belong not only to savages, but are the inherited customs and traditions of past generations, long forgotten. In the hinterland of the British Isles, of Germany, Austria, Hungary, etc., and of North America, no meal is considered complete without meat as the leading component. In our younger days, fruits, nuts, and often vegetables were considered but appetizers, and salads as foods were not thought of at all. In fact, it may be suspected that in many cases the inordinate craving for sweets and rich desserts by children may be induced by an excess of animal foods, such as meat and eggs in the diet; these being acid-forming in character. Such foods eaten disproportionately seem to produce also an unnatural, artificial hunger for food between meals, and this may be due to an overstimulation of the gastric secretions.

SOME NEWER IDEAS ON NUTRITION

It is remarkable what changes have taken place in our conception of nutrition within the past few years. Many foods and their juices which were formerly considered impossible of digestion and metabolism in the raw state, are now a part of the diet of infants and children. Raw tomato, carrot, and onion juices are, at the present time, essential additions to infant feeding. Other foods long considered indigestible in the raw state are now found to be at least partly digestible. Raw starches have been held to be quite indigestible and unmetabolizable in the child's organism, yet Fotanow conducted a series of experiments on human subjects with small quantities of raw wheat, oat, rice, and potato starches, and found that those of the raw wheat, oat, and rice were almost completely assimilated, while the raw potato starch was only from two and one half to four times less easily digested. It must be admitted, however, that as he used only fifty grams of raw starch, it may have been lost in the

intestines. In a long, patiently conducted series of experiments, the raw corn and wheat starches were found to be completely assimilated and no trace of them could be discovered in the feces. Other experiments with the raw potato starch, made on children, gave values for its digestibility which varied from 62.3 to 95.2 percent, the average being 78.2 percent. It seems that the ingestion of the potato starch caused disagreeable physiologic disturbances which were not observed in the other experiments with the raw corn and wheat starches.[14]

CEREALS

Cereals are composed of water, protein, fat, carbohydrate, cellulose, vitamins, inorganic salts, and lecithin. Their chief mineral salts are potassium and phosphorus, and magnesium is present more abundantly than in lime.[4] The cellulose encloses within its walls all the nutritive principles of grains. Cereals are utilized chiefly for their carbohydrates, which yield the most important oxidizing material with the least expenditure of effort on the part of the growing child. They are biologically economical because of their complete utilization and because the energy required for their digestion is much less than for that of the fats and proteins, and being nitrogen-retentive they aid in the assimilation of the fats and proteins. Cereals have a water retentive power. In cases of marked malnutrition with dehydration and loss of mineral salts, it has been observed that the excretion of urine was less during cereal gruel feedings than when no cereal was used, although the fluid intake was the same.[15]

CLASSIFICATION OF CEREALS

Cereals may be conveniently grouped into three classes:—first, the oat group; second, the wheat group; and third, the maize group. The oat group stands at one end of the list as a typical muscle or energy producing food, while the maize group is at the other end as a fat and heat producer. While starch is practically the only carbohydrate present in most grains, a few contain sugar as well, notably corn meal, sweet corn, and the sorghums. While stressing the importance of the carbohydrates, fats, water content, mineral matter, and high phosphorus content of the grains, we must not overlook the great value of their proteins, which vary in kind and value as tissue builders in the different grains.[16]

CEREAL PROTEINS

While cereals are prescribed to promote growth, primarily on account of their starchy character, either alone or in combination with fats such as butter, a selected few have an additional advantage in that they contain sugar. The proteins of grains, while not so potent as those of the flesh foods, should not be underestimated in the nutrition of children, particularly of sickly children. In health and in illness, a gruel ration should be a part of the child's daily food. When split up during the process of digestion their component parts are easily assimilated and metabolized.

Murlin and his associates tested the rapidity of protein digestion of different cereals according to the emptying time of the stomach, as measured by the nitrogen in the ingested food obtained at successive intervals and according to the rate of nitrogen excretion through the kidneys. In Murlin's experiments, four human subjects ingested 25 grams of dry cereal, properly cooked, to which had been added cream and sugar, and, in some cases, coffee. The same course was followed on successive mornings. The fecal elimination time in these subjects was found to be two and one half hours and it was two hours after the ingestion of the food when the stomach emptied itself. In the second week a different cereal was eaten, in the third, another, and in the fourth, still another.

It may be of interest to note that the cereals used in the tests were a milled wheat product, a whole wheat product, and two oat products. The differences in the emptying time of the stomach for the four cereals proved to be slight. An average was taken of all the subjects and for all the cereals, and the results indicated that at the end of one hour, 35 to 45 percent of the cereal protein eaten had passed out of the stomach. At two hours, about 75 percent was eliminated, and at three hours, the stomach was found to be entirely empty. The oat protein tended to leave more rapidly during the early part of digestion but was rather slower during the remainder of the period. An absorption rate was obtained from two subjects which showed that the nitrogen of the milled wheat product appeared regularly sooner than the corresponding nitrogen from the ingested oats.

Murlin and his associates found that the percentage utilization of the cereals used was as follows[17]:—

Cereal	*Percent*
Milled Wheat	99.5
Whole Wheat	87.2
Oats	86.7

Both vegetables and cereals furnish proteins, those of wheat being nearest in value to those of milk. Incidentally, normal growth in children is probably not secured below a nine percent protein level. When considering the proteins of milk, legumes, and the grains, those of milk are easily superior to the other two. However, if they are combined, while not making good each other's deficiencies, they do become a valuable and nutritious source of nitrogen in the diet when added to meat proteins. Rye and flaxseed meal proteins when combined form a valuable nutritive. Naturally the conclusions concerning the various proteins cannot be drawn as exactly from laboratory experiments with small animals as they can when tested clinically with children.

Stefansson states that dental caries was rare among Icelanders prior to 1850, although they lived on a diet high in animal protein. This consisted, for the most part, of milk, mutton, fish, fowl, and their eggs. Although the explorer did not mention it in this connection, we understand that in the summer they eat some watercress, turnips, potatoes, and possibly other plants. With the addition of cereals, sugar, and canned foods to the diet, teeth defects appeared among them. It would appear, however, that among the more primitive Esquimau tribes muscle tissue and fats predominated in the diet, while the blood of their kill is also saved and later eaten. It is the glandular structures, however, which are looked upon as "les pièces de resistance." [18]

When planning diets for children, care must be taken to estimate the biologic value apart from the digestive value of foods containing protein, for the two may be widely separated. Mitchell and Carman have shown that though the biologic value of the total nitrogen of lean pork is not much greater than that of wheat, it ranks among the best of protein foods because of its high "net protein" value. We have had cases of somatic disturbances in young Chinese children which were caused by the eating of pork.

Mitchell and Carman found that in spite of the percentage of losses incurred in digestion and metabolism, the net protein content of eggs was 12.5 percent; whole wheat, 7.6 percent, and lean pork 14.6 percent.[19]

CEREAL NUTRIENTS

Like fruits, vegetables, and meats, cereals possess a characteristic nutrient which may be more abundant in one than in another. Following, then, the premise that in the balancing of metabolism all grain nutrients are essential, it is logical to believe that children require all the different cereals. The grain proteins found in wheat are gliadin; in barley, hordein; and in maize, zein. It is known that hordein is related immunologically to the gliadin of wheat and rye, and it is possible that all three may be responsible for certain peculiar and not-understood antigenic reactions which often occur in susceptible children. On the other hand, no such disturbances are brought about by the zein of maize.[16]

Much has been added to our knowledge of the relative vitamin content of the several layers in the cereal grains. The peripheral layers and the germ are considered rich in vitamins. However, apparently little is known regarding the relative supply of proteins in these various layers. We shall therefore consider the chemical and biological analyses of the proteins contained in the grains, as far as this work has progressed. For instance, under experimental conditions, the milling fractions of wheat and corn were analyzed to determine their content of total protein, gliadin, globulin, and glutenin. Chemical analysis showed that among the samples of wheat under consideration, bran, middlings, red dog, first clear, second clear, and patent flour (descriptive steps in the milling process), the gliadin content tended to increase as the milling process advanced. At the same time it was shown that the globulin content was much higher in the bran, in the standard middlings, and in the red dog than in the three grades of flour used. It was shown also, that the glutein content diminished as the work proceeded from the outer layers to what represents the patent flour. The corn cereal used in the test showed similar results. Corn meal is richer in zein, a nutrient which corresponds to the gliadin of the wheat, than is corn-feed meal, but the latter is undeniably richer in glutein than is the corn meal itself. It would seem logical to draw the conclusion that the peripheral layers of the cereal grains contain more of the dietetically balanced protein than does the white flour.[20] The proportion of fat also varies in the different members of the cereal family, being most abundant in the cereals of the northern latitudes and almost absent in those of the tropics. Thus does nature fit her foods for climatic exigencies.

THE GENERAL COMPOSITION OF THE CEREALS IS PRACTICALLY AS FOLLOWS:—

	Percentages
Water	10—12
Proteins	10—12
Carbohydrates	65—75
Fat	½—8
Mineral matter	½—8

The grains may be also divided roughly as to their nutritional considerations into two general groups; the one typified by oats or wheat, which are relatively high in protein and similarly low in carbohydrates, the other typified by maize, relatively low in protein but rich in the carbohydrates. In composing diets for infants and for children, it is well to note that oats and corn are dissimilar in the amounts and kinds of their nutritive constituents. On the other hand, rye and wheat show but slight differences. Detailed nutrient percentages of some of the common cereals are listed below.[15] Koenig estimates, for example, the mean composition of wheat taken from two hundred and fifty analyses as follows:—

COMPOSITION OF THE COMMON CEREALS

WHEAT

	Percentage	
Water	13.56	
Nitrogenous substances	12.42	
Fat	1.70	
Sugar	1.44	
Gum and dextrin	2.38	
Starch	64.07	
Fibre	2.62	
Ash	1.79	not included in Russian wheat

MAIZE OR INDIAN CORN[7]

Analyses of A. Riche and of A. H. Church

	Percentage A. Riche	A. H. Church
Water	17.1	12.5
Albuminoids	12.8	9.5
Starch	59.0	7.70
Dextrin and sugar	1.5	
Oil	7.0	3.6
Cellulose	1.5	2.0
Ash	1.1	1.17

Olson and others have pointed out the variations in the sodium content of wheat. Miller has arrived at the conclusion through experimentation that even eighty percent of corn in a ration does not supply sufficient sodium for the normal child's growth, and that in this respect it is dependent on other sources. However, a corn ration does supply enough chlorine for growth in children and for gestation and lactation in women.[21]

OATMEAL

Composition	*Percentage*
Water	12.92
Nitrogenous matter	11.73
Fat	6.04
Sugar	2.22
Dextrin and gum	2.04
Starch	51.17
Fibre	10.83
Ash	3.05

The nitrogenous substance of oatmeal is gliadin or plant casein, which has a much higher percentage of sulphur than the gliadin of wheat. Van Betra states that it has 1.24 to 1.52 percent of albumin, and possesses a greater proportion of fat than some of the others. For instance, its fat contents are glycerin, 2.8 percent, oleic acid, 60.5 percent, and stearic and palmitic acids, 36.7 percent.

BARLEY

Composition	*Percentage*
Water	15.06
Nitrogenous substances	11.75
Fat	1.71
Carbohydrates	70.90
Woody fibre	0.11
Ash	0.47

Its nitrogenous substances are hordein, glutenin, leucosin, globulin, and the proteoses,

RYE

Composition	Percentages
Water	14.24
Nitrogenous substances	10.97
Fatty matters	1.95
Sugar	3.88
Gum	7.13
Starch	58.73
Woody fibre	1.62
Ash	1.48

Its nitrogenous substances are gliadin, leucosin, edestin, proteose, proteids; its fats are glycerin, 1.30 percent, oleic acid, 91.60 percent, palmitic and stearic acids, 8.10 percent.

RICE [7]

Composition	Percentage
Water	14.41
Nitrogenous substances	6.94
Fat	0.51
Starch	77.61
Woody fibre	0.08
Ash	0.45

BREAKFAST FOODS

Figuratively speaking, the raucous tones of the calliope, the clang of cymbals, the moaning of the saxophone, and the broadcasts on the radio have ushered in "Der Tag" for the modernized breakfast foods. Unquestionably much can be said for these cereals, much against. The dietetic value of the various commercialized breakfast cereals depends largely on their manner of preparation, on the biologic worth of their raw materials, and on the ease with which fluids such as milk and cream may penetrate to their interiors so that they may be made suitable for digestion and assimilation. Quite apart from their biologic value, it may be found that some of the commonly advertised breakfast foods are incapable of being softened enough to pass through the stomach and intestines without more or less irritating the mucous lining, thereby causing at times a mucous diarrhoea.

Wodehouse says that heating to a cooking temperature does not destroy the anaphylactogenic properties of wheat. However, the temperatures employed in the baking of bread do somewhat reduce these activities in most cases. When the whole seeds of wheat and of some of the other cereals are heated in a crucible until they become a light tan color throughout they are found to have lost their potency completely. This was discovered, says the author, in the many prepared cereal foods which are said to be cooked at temperatures much exceeding those reached by an ordinary autoclave. Many of the over-advertised present-day foods apparently come under this category.

It is of particular interest to read that in a certain test when concentrated aqueous extracts were made from certain grains and used as skin tests on patients who were strongly sensitive to the corresponding raw cereals, no reaction whatsoever was obtainable. Their original cereals, however, lost their potency during the process, and, although their subsequent ingestion caused no sensitization in the susceptible patients, they also proved very poor in food value. According to our own clinical experience, it would seem that a child possibly sensitive to one wheat protein may not be affected by the protein of another. The common practice of cooking the raw cereals in a double boiler greatly enhances their digestive value.[22]

THE CEREALS PROCESSED

While fruits, vegetables, and other perishable foods may suffer from transportation, the grains may travel far or be kept in storage for years without deterioration. When food is burned, its organic material is converted into gases and disappears, while its inorganic or mineral substance, the ash, remains behind. In preparing food tables, it is, therefore, necessary to include the ash percentage of the particular food along with the other nutrients.

A knowledge of the process by which cereals are rendered useful may be of interest. First, the raw product is prepared by crushing the grains to different degrees of fineness after decorticating them. Second, there are partially cooked preparations from these grains. Third, there are the malted cereals, in which the moist grains are ground and mixed with malted barley so that a portion of the starch is converted into maltose and dextrose, after which the mixture is crushed between hot rollers and then dried. The composition of many highly advertised breakfast foods is as follows:—

Name[23]	Moisture	Protein	Total Carbo-hydrates	Crude Fibre	Fat	Ash
Pettijohn breakfast food...	9.51	10.56	76.96	2.01	1.45	1.52
Cracked wheat...........	9.30	12.60	74.42	1.49	2.22	1.46
Quaker Oats.............	9.40	17.20	66.65	1.40	6.08	1.67
Bulk oats................	8.07	17.74	65.89	0.99	6.52	1.78
Cerealine (corn)..........	9.55	9.90	78.75	0.72	1.24	0.56
Cream of Wheat..........	10.69	11.75	76.17	76.17	0.95	0.64
Vitos (Pillsbury)..........	8.74	12.69	76.56	76.56	0.98	1.03
Wheatena................	8.41	11.50	75.23	1.03	2.10	1.73
Zwieback................	10.64	14.31	68.87	4.21	0.49	1.48
Grape Nuts..............	8.00	12.73	73.78	2.02	1.57	1.90
Toasted corn flakes.......	9.63	9.21	78.31	0.57	0.54	1.74
Shredded wheat..........	9.45	11.06	76.41	76.41	1.42	1.66
Puffed wheat berries......	10.19	13.06	73.72	73.72	1.63	1.61
Trytasta food............	9.69	11.81	72.47	2.57	1.08	2.77

When the composition percentages of the raw grains are contrasted with similar percentages of the commercialized foods, it will be noticed that there is no great variation in their composition, as some cereal manufacturers would have us believe. The oat products are high in protein and fat, and the wheat cereals, although sold under different names, are similar in composition. The flake malt breakfast foods, so popular in the families of the well-to-do, are somewhat similar in character, although the converting action of the malt used in many of them changes a fair percentage of the starch to reducing sugar. However, this process rather tends to make the protein content less digestible. The larger portion of the starch contained in these malted foods probably remains unchanged, other than that which is converted by the action of the malt.

The manufactured products made from wheat, corn, or oats are therefore in no way superior to the original food cereals which have outlasted time. They are seemingly not so digestible nor so metabolizable. Grain cereals contain a considerable amount of fibre which in a way diminishes their nutritive qualities, but at the same time renders them useful as laxatives in an otherwise constipating diet, because of a mild irritation of the intestinal walls. For the average normal child, crude grains properly cooked are extremely valuable in the balancing of metabolism; it is our contention that all foods served for nutrition must be as close to their natural origin as possible. With normal, healthy children the use of predigested sugars and starches upsets the digestibility of the other substances in the

diet. This does not apply, however, in those cases of gross dysfunction where particular predigested foods have to be given. Every physician should be able to prepare infant food modifications from the natural foods which are in common use.[23]

UNRECOGNIZED GRAINS OF VALUE

The pediatrician is constantly striving to add to the infant food feedings and to the children's diets unrecognized foods which are easily digestible, assimilable, and metabolizable. Artificial nutrition in infancy can never be made to correspond to good breast milk, for the latter is a natural product, the result of proper food metabolism in the mother. The best that one can do, therefore, is to add to the infant's dietary more foods, and at an earlier age than was formerly considered advisable. It may be prophesied that in the future suitable foods will be formed of the alfalfa grass and perhaps of seaweed and of other plants. Pediatricians would like to see the return to more general use of cracked wheat as a breakfast food, and of foods prepared from Irish moss.

Gallup made a series of nutrition studies on the importance of cotton seed proteins. Frapo fed cotton seed meal to steers and reported a value of 88.4 for the coefficient of digestibility of the proteins contained. Mendel and Fine obtained a corresponding estimate of 67 to 75 on dogs. Rather, using men as subjects, acquired an average value of 78 for the proteins of cotton seed flour. Osborne and Mendel found that as little as six percent of cotton seed-flour protein was capable of supporting considerable growth in animals. Beside the proteins of importance, the meal also contains vitamin B. It must be said that the full value of the seeds can be realized only after the removal or destruction of a substance called gossypol, and then in such a manner as not to lower the nutritive value of the other ingredients. The proteins in the meal are less digestible than in the seeds when the gossypol is removed.[24]

CEREAL BRAN

In the various maladjustments of childhood in part related to unbalanced metabolism, constipation stands out as one of the most common. Until nutrition and the various environmental factors are aligned in the balancing of the metabolism of the child, it is wise to eliminate waste food excreta in the intestinal tract by natural means; in short, to use a cereal laxative, a bran.

In a series of studies on dogs as to what constituents of the wheat bran, for example, were responsible for these laxative effects, Williams discovered that washed bran (starch free) was laxative when taken into the body in amounts ranging from 10 percent to 0.5 percent by weight, and that the average minimum effective dose was two percent, or two hundred to two hundred and seventy-five milligrams per kilo of body weight. He found, too, that the crude fibre of bran was a much more potent laxative than was the bran itself. Possibly a combination of this crude fibre with a product called pentosan was responsible for this effectiveness. In fact the crude fibre alone proved to be a surer laxative than an equal amount of powdered agar.[25]

The mechanical effects of bran are not its only characteristic; it has nutritive qualities as well, which are found in its proteins. The proteins of wheat bran differ, paradoxically, from the corresponding proteins of the wheat endosperm and from the wheat embryo, for they are high in their content of the basic diamino-acids and they contain larger quantities of the nutritionally essential amino-acids than are contained in the endosperm proteins. It is not universally known that the quantity of the basic amino-acids in the bran globulin, particularly those of arginine and lysine, exceeds that supplied by most vegetable proteins. Bran albumin also has large quantities of tryptophane, tyrosine, and cystine. Bran prolamin, a protein which corresponds to gliadin of the endosperm, contains as much of these amino-acids as is present in most seed proteins and much more than is contained in gliadin. Wheat endosperm, the commercial white flour, holds approximately 11 percent of protein and 80 percent of gliadin and glutenin.[25]

THE PROTEIN EFFICIENCY OF VARIOUS BRAN COMBINATIONS

We have noted in our clinical studies a certain tolerance on the part of the child for one particular bran food, especially when it was served exclusively over a long period. There is also apparently an individualistic trend to a certain bran which proves more efficacious than another. For instance, one child turns to wheat, another to rice bran. Undeniably some children favor an alternate feeding of different brans or a mixture of two or three kinds of bran at the same time. The colorings of the different bran foods attract certain children, much as does the vari-colored ice cream brick. Not only are many of these bran

combinations more appetizing, but they have higher protein value when combined than when eaten alone. In conclusion, a mixture of both vegetable and animal proteins, a combination of many cereals or of cereals and bran, whether wheat or rice, have a higher food valuation than the proteins of any single one of these products.[26]

THE SUGARS

When one sees a delighted child contentedly sucking a varicolored stick of candy, conceivably the act may signify many things. The taste alone may be delightful, the organism may need the nutritional qualities of the sugar, or both factors may come into play at the same time. For the flavor of sugar, together with its undeniable nutritive value, accounts for its great popularity as a food. Infants and children need sugar, they crave it, and it is one of the many nutrient factors which harmoniously aid in replenishing deficiencies of the organism and balancing metabolism. Sugars belong to the carbohydrate group, because they contain carbon in chemical combination with oxygen and hydrogen. The other carbohydrates which are closely related to the sugar group are the starches and cellulose. The sugars and starches supply the bulk of the energy of the diet. At a temperature of 320° F, sugar melts to a colorless liquid which rapidly takes on an amber hue. If cooled quickly it hardens to a glassy mass, transparent and brittle. Colored with innocuous vegetable dyes, and in the form of sticks, sugar may assume all the colors of a barber's pole. Hence the popular barley candy during the Christmas holidays.

Brown sugar, at once old and new fashioned, so much used by us in infant food modifications and in children's diets, owes its color and flavor to caramel, the result of heating the sugar to above 320° F.

In spite of occasional hysterical outbursts concerning the ingestion of excessive amounts of sugar as causing tooth decay, sugar is a very necessary food for balancing metabolism. To totally eliminate sugar from any source from the dietaries of healthy, and in many cases of unhealthy, children would be a grave mistake biologically. Consider for instance a starchy food, the mealy, baked potato, generally liked, easy of digestion and easily metabolizable, but which, like all forms of starchy foods, must be largely converted into a particular kind of sugar by the digestive juices before it can be metabolized. The American diet shows a sugar consumption of 5.4 percent sugar furnishes 17.5 percent of the

otal energy of the diet. The sugars in general, and fructose or ruit sugar in particular, show a high rate of digestibility, they ncrease the available energy of the whole and otherwise bal-nced ration about twenty five percent, but, a fact sometimes not ppreciated, they do not affect the proper digestibility of the oods with which they are combined. On the contrary, they end to render them even more digestible and metabolizable. A elatively large amount of sugar can be eaten by the active, ealthy child without danger of undue fermentation in the diges-ive tract, if the remainder of the food is properly adjusted.

CLASSIFICATION AND USAGE

Sugars may be divided into two major classes, the monases nd the bioses. The common representatives of the monase roup are first glucose or dextrose, the latter known as grape ugar. Glucose is often used commercially as a substitute for ane sugar in syrups, candy, and in preserving fruits. It is harm-ess and wholesome. Second, is levulose or fruit sugar, also called ructose. The chief representatives of the bioses are, first, cane ugar or sucrose saccharine, second, maltose or malt sugar, and, hird, lactose or milk sugar.[27] Glucose is found in the juices of nany fruits, notably in grapes. It is about three fifths as sweet s cane sugar, is good and wholesome, and is a biologically utritious ingredient of many foods, such as cornstarch pudding. The main sources of both the beet and cane sugars are found n solution in many plant juices, in the stems and roots of grasses, specially in sugar cane, sorghum, and in corn stalks. They may lso be found in the beet, carrot, turnip, and sweet potato, in he sap of trees, as the sugar maple, in almost all the sweet fruits, nd in the nectar of flowers.[28]

Levulose is found in the juices of fruits as well as in honey. Cane sugar, by inversion, is changed to dextrose and levulose and contains from fifteen to twenty percent of fructose, while the sugar of the beet, so widely distributed in Europe, yields from en to twenty percent. Maltose or malt sugar occurs in malt and is an intermediate product in the formation of alcohol from starch. Lactose or milk sugar is found in the milk of mammals; cow's milk contains about five percent. Through fermentation, alcohol and lactic acid are formed. Fruits in general contain an appreciable amount of sucrose mixed with other sugars and with the organic salts.[27]

Beet sugar and, to a lesser extent, unrefined cane sugars, such as the brown variety, contain a large amount of minerals, par-

ticularly potassium and sodium carbonates, which arise from the decomposition of the citrates, maltates, oxalates, etc. They also contain nitrates. Brown sugar is valuable both in infant modifications and in the dietaries of older children. Cane sugar ash is found to contain little soda but plenty of lime, magnesia, iron and aluminum. In cane and beet sugars, the amounts of potash are about equal, but in the beet ash there is thirteen times more soda than in that of cane sugar, beside magnesia, the oxides of iron, and also aluminum in small quantities.[7]

Honey is a metabolized product and is invaluable in the nutrition of infants and children. Unfortunately, in pediatrics, it has not been placed in the high position it deserves. If genuine, it is a mixture containing not more than eight percent, usually not over two percent, of sucrose or of crystallizable sugar, plus equal amounts of the two sugars levulose and dextrose.[23] Honey also contains minute quantities of wax, formic acid, and other organic acids, pollen, and an alkaloidal and bitter principle of plants. It contains small quantities of cane sugar and of mineral matter as well as small amounts of alcohol. This biologic sugar has a moisture content of seventeen percent and an ash of 0.18 percent.[7] Most of the sugar of honey occurs in an inverted state. It is wholesome and easily assimilated, especially in moderate quantities. Honey is even richer in sugar than are the malt extracts and its persuasive quality and attractiveness are dependent on the kind of flowers sucked by the bees.[23]

SUGAR AND THE BODY STATUS

The amount of sugar, its kind, and when and how it is to be prescribed, are questions of great importance. The short, stockily built child is prone to take on fat. Often his rate of metabolism is low and he may tend to hypo-function of the endocrines, especially of the thyroid gland. Such a child rather favors a more or less sedentary or phlegmatic life and his digestive organs are often very delicately balanced. In this instance, cane sugar should be given only in very moderate amounts; greater quantities of fructose and even of honey are better borne. On the other hand, infants and children of a happy, energetic disposition, who enjoy the normal biologic reactions of a well ordered nutrition, and in consequence possess a good digestion, can digest and metabolize a large amount of cane sugar without ill effects. Sugar in quantities from 4 to 5 ounces a day may be easily utilized by these children. However, other active children,

n all respects normal but restricted in their play and outdoor reedom in the large cities, often suffer from indigestion due to he ingestion of large amounts of cane sugar, usually in the orm of cheap candy.

Cane sugar and beet sugar are concentrated foods and as such re especially adaptable to normal children. This is not hard to nderstand when one realizes that the relatively small body of he child loses more heat from the skin for every pound of body weight than does the adult.

Children, because of their more active life, require proporionally more heat units in their food than do the older members of society. Obviously, sugar, like any other food product, used n excess, may become a menace to health. One infrequently inds a distaste for even milk when it has been too highly sweetened. A milk sensitization may occur for this reason, particuarly where the other nutrients of the diet have been limited, thus throwing a burden on metabolism.[28]

ADVANTAGES AND DISADVANTAGES IN SUGAR INGESTION

The great advantage of sugar in the child's diet, whether cane syrup, maple syrup, mixed syrups, honey, molasses, brown sugar, etc., is that it offers in a concentrated form the most available, the most attractive, and a much needed carbohydrate. The sugars act in the body as energizers, and, taken proportionately to the biologic need of the organism, they throw but little burden on the digestive organs. It is clinically noticeable that an overindulgence in sugar may result in an absorption of some of it, but the remainder may be excreted by the kidneys in the form of a foreign body. A concentrated mass of sugar in the stomach tends to absorb water and thus causes an irritation of the mucous lining, while a continued ingestion may eventually cause an inflammation of the stomach mucosa. As sugar is slow in leaving the stomach, there may follow an intestinal fermentation, with the production of irritating substances which may produce a pruritus so intensive that the child may tear at the rectum with his hands.

THE FATE OF THE SUGARS IN THE CHILD'S BODY

Watch a child smash a watch to see how it works. The physician less spectacularly studies the course of the sugars as

they travel down the digestive tract in the human organism, likewise to see how they work. Let us then follow the fate of sugar in the child's body. Our observations may be divided into four parts:—(1) first, the absorption of the sugars from the intestinal tract; (2) second, their passage by the blood and occasionally their elimination in the urine; (3) third, their penetration into the tissues; and (4) fourth, their disposal in the tissues. The first two steps are comparatively easy to follow. Sugars such as galactose, mannose, fructose, and the pentoses are different from the other kinds in that they are normally cell constituents. For instance, in an experiment on male and female albino rats it was found that fifty percent solutions of the hexoses (glucose, galactose, fructose, and mannose) were absorbed from the intestine at a rate constant for each sugar. Even after the absorption of seventy percent of the sugar originally introduced, the rate of absorption was not diminished. Hence, this rate of absorption of the hexoses is seen to be independent of the absolute amount and also of the concentration of the sugar present in the intestine. Twenty-five, fifty, and eighty percent of glucose solutions were found to be absorbed at the same rate; evidence, it would seem, that the rate of absorption is independent of the sugar concentration present. When glucose was fed to rats in as large amounts as fifteen grams per kilo, it did not lead to sugar excretion in the urine. With a little thought, one is able to compute for children larger amounts of sugar, which can be properly metabolized and do not appear in the urine. Nearly fifty percent of the total amount of galactose was found to be absorbed and eliminated in this manner.[29]

Another experiment presents an even more illuminating picture in nutritional work with children. This test was also performed with normal animals, and it was seen that during the four hours of sugar absorption, for one hundred parts of the absorbed sugar, thirty-eight parts were oxidized, while thirty-six were deposited as glycogen in the muscles, and sixteen parts in the liver. Glucose and fructose are on a par as glycogen formers, even though the former is absorbed twice as fast as the latter. Galactose, however, plays an unimportant role as a source of liver glycogen. After four hours of a glucose or fructose absorption, glycogen formation in the liver ceases or is strikingly diminished, which indicates that a glycogen maximum has been reached. With some children, sugar absorption is not always smooth sailing, for an inherited predisposition to intolerance or a true dysfunction may interfere with the progressive steps in absorption.[30] In most cases these dysfunctions are of minor im-

ortance, but occasionally one does find a marked dysfunction n sugar absorption. In certain disease conditions, notably in rthritis, there is a low sugar tolerance. Probably many cases which tend to the acid side of the acid-base equilibrium have an qually low sugar tolerance.

Much work must still be pursued in this direction. It has been hown that an exaggerated and prolonged hyperglycemia can e induced in some sensitive subjects by elevating the child's egs and one arm, a position which interferes with the blood upply to the large muscle groups. One can therefore appreciate hat the rate at which the sugar leaves the blood after a glucose ngestion may be strongly influenced by the character of the lood supply to the tissues which are active in sugar removal. While admitting that experiments with the lower animals are nalogous with those of children in minor biologic characteristics nly, yet it must be said that the lower animals possess the same ody formation and that the experiments, while not conclusive, ertainly do aid in establishing a working basis for the nutrition f children.[31]

MOLASSES

Recollections of childhood bring memories of molasses meared on bread, for this form of sugar was once considered ot only delicious but a wholesome and valuable food in nutrition. Its popularity, now rather at a low ebb, should be reestablished, as it is a valuable mine of sucrose and invert sugar, nd it is tasty. Molasses, or treacle, as it is often called, should e prepared by what is termed the open kettle process. An lmost perfect cane sugar food for children is the expressed raw uice of the fully ripened sugar cane known as brown sugar, ather than its crystallized product. Brown sugar contains many utrients other than the carbohydrates, which are elaborated y the sugar cane and which, in the plant, are used for the uilding up of young leaves and buds.[28]

Care should be taken to use only good molasses, as it contains much of the sucrose as well as the ash and other constituents of the cane juice. This latter should not contain more than twenty-five percent of water and five percent of ash. It is essential that the molasses be withdrawn at a relatively early stage in he process of sugar making, for the syrupy liquid known as "refiner's syrup" which remains at the end of the process contains but very little sugar and is not an edible product per se.

SUGAR FLAVORS

Most fruits and fruit juices derive their flavors to some extent from a mixture of glucose and fructose. Raw cane sugar and raw beet sugar show marked differences in flavor, the former having a pleasant taste which is well liked, while the raw beet product is bitter and often unpleasant. Practically both sugars are alike in character, but the former is of the hexoses, and the latter is not.

VITAMINS IN THE SUGARS

Very little need be said of the vitamin content of sugars. With the exception of vitamin B, found in molasses, they are absent in glucose, honey, and cane sugar. Their showing is therefore not impressive.[2]

FATS

In the treatment of inherited and somatic sub-minor, minor, and intermediary types of dysfunction, the administration of fats plays an important part. In the gross dysfunctions, principally those inherited, this treatment may invite danger. The addition of all kinds of foodstuffs, all types of nutrients to the diet of the child in proportionate and individualistic amounts, spells balanced metabolism, and each nutrient, be it ever so little in proportion, aids the others in nutrition.

Fat is one of the three important principles of the foodstuffs, and like the carbohydrates and proteins it is a prolific source of energy. It is found abundantly in the animal and vegetable kingdoms. Fat is present in the child's organism in two quite different forms. Inert, it is stored as a reserve in the various fat depots of the body and is unfit for vital purposes. Active, it splits when it oxidizes and when it blends with other substances, and takes a part in balancing metabolism. It is a source of grave concern that the fear of obesity has marked an era when fat foods have been largely excluded from the diet and when too restrictive dieting has come into fashion. Inert fat, while it may serve no active purpose, tends to accumulate in various primary and secondary depots of the body, where it acts as a store of reserve force. This storage may be of a temporary character, of limited capacity, or it may be of a more permanent nature.

In our experience, the kind of storage would seem to depend n dietary habits, on inheritance, on race, or it might be wholly dividualistic. Possibly it is influenced also by the harmonizing nctions of the endocrines, perhaps by an inherited status, or simpler language, by the disposition of the child. With an nderstanding of metabolic activities, one may be interested fat storage only from an artistic standpoint, as seen in the otundity and contours of the body curves, which, unless the eposits are excessive, are a mark of beauty.

A temporary reserve of fat in an active child is acted upon by e enzymes of the tissues, then desaturated and phosphorized, ainly in the liver, but to a lesser extent in other places, before is utilized for the production of heat and other forms of nergy. In supplying fat foods to infants and children in indi-dualistic proportions, the body is spared the synthesizing of ts from proteins and carbohydrates, processes which often result n an unnecessary exhaustive outpouring of energy. The biologic ell also stores up fat in inactive form, but in a small measure as tty acids, lecithin, and largely as the phosphole cithins, which onstitute the primary elements of the cell and are highly essen-al in metabolism, for they are concerned in the formation of s nucleus. Many of the most important and vital properties f cells depend on the lipoids, of which phospholecithin is the oremost example. The growth of the infant's brain is deter-nined by the quantity of lecithin present in the mother's milk. Vicious consequences follow when the lipoids are extracted from he child's food, for the fat soluble vitamins are removed at the ame time and growth is retarded.

It is of interest to know that the amino-acids, derivatives of he proteins, are lipoid solvents, and as such assist the entrance f the lipoids into the cell. Also of importance is the fact that hese lipoids which surround living protoplasm seemingly act s a kind of sieve in preventing the entry of injurious agents nto the cell and in facilitating the admission of useful ones, for hey render soluble many food products for easy entrance into he cell.

Lock and Bentner believe that these lipoids confer on the ells the property of bio-electric potentiality, enabling them to espond to physical and mental stimuli. Furthermore, because of the intensive necessity of fats in the dietary, as are these lip-oids, products of the fats are found in the various endocrines. The thyroid, adrenals, anterior pituitary, thymus, and gonads contain them, and their presence may determine the endocrinic activity affecting metabolism, and consequently, growth.

When the food of the normal child contains an excess of fa there may appear, after digestion and absorption have take place, not only an increase of fat in the blood, but also o cholesterin and lecithin, showing that these bodies are con cerned with metabolism. While the normal proportion of leci thin and cholesterol in the blood is constant, an over-amount o them induces hemolysis, as is found in diabetes.[32]

FAT IN DISEASE

The role of fat in disease is in many respects of no less im portance than it is in health, for inherited characters potentiall inclined to certain diseases may induce even worse conditio than those dysfunctions of inheritance. While the presence o fat in the bacterial cells gives them a certain protection, fats ar found associated with various forms of degeneration such as auto lysis, caseation, gangrene, atrophy; and their toxic intermediar products cause intestinal toxemias, ketonuria, and acidosis. Ac cording to Brinkmann, the normal hemolytic activity of th blood serum probably depends on the fatty acids and soaps while in pernicious anemia the power of the serum to protec the corpuscles from hemolysis by the oleates and by saponin i decreased. The acetone bodies are chiefly from the fats, althoug they originate in the carbohydrates and proteins. In infants suf fering from acid intoxication and acetonuria, these acetone bodie spring from the products of the decomposition of the fatt acids.[32]

FATS AND CARBOHYDRATES IN THE MOTHER'S NUTRITION

We cannot speak of fat and carbohydrate nutrition in childre without being reminded of the part these two substances pla in the nourishment of the fetus and of the nursling. In balancin the nutrition of the mother, particularly as to fats, it must b realized that there is a marked difference between the formatio of fat which is absorbed by the fetus from the placenta, and tha form which is necessary for utilization by the nursling from th mother's breast milk. Indeed, in choosing a proper diet for th expectant, as well as for the nursing mother, it should be rec ognized that her metabolism should function at a temperatur of about 38° C., but in the nursling this functioning takes plac at a lower temperature; therefore, the mother's diet must b adequate to meet these conditions.[33]

)IFFERENCES BETWEEN BREAST AND COWS' MILK

In earlier days it was conceded that the fat particles in breast ıilk were smaller and more uniform than those of cows' milk, hereby favoring fat assimilation. Holt and his associates did not iscover these differences. They studied the retention in diets in hich extreme variations in the size of the fat globules were roduced. Experimenting with three diets; namely, homoenized milk, natural cows' milk, and fat-free milk in which the ppropriate quantity of fat was supplied in emulsified form, they rew the following conclusions:—

EFFECT OF PARTICLE SIZE ON FAT RETENTION

Diet	No. of Experiments	Percent of Fat Intake Retained (average)
Iomogenized Cows' Milk................	12	88.7
Jnhomogenized Cows' Milk..............	4	88.3
utter Fat Unemulsified................	4	94.1

Holt and his associates also studied the influence of the volaile fatty acids in the food fat. Cows' milk contains far more of these acids than does breast milk, and these short chain acids have been thought to be harmful. An attempt was made to ccentuate such effects as these volatile fatty acids might produce by increasing the potence of butter well beyond the normal igure. This was done by adding to butter a distillate of free volatile acids obtained from butter, and also by adding pure ributyrine.

EFFECT OF INCREASING REICHERT–MEISSL NUMBER OF BUTTER

Feeding Used	R–M No. of Food Fat	Percent of Fat Intake Retained	R–M No. of Stool Fat
Average of 20 experiments on butter fat	31.4	89.7	1.7
H6 — Butter + Free volatile acids....	53.1	90.7	
H7 — Butter + Free volatile acids....	53.1	84.1	
V4 — Butter + tributyrin..........	48.0	90.1	9.0
KJ 11 — Butter + tributyrin........	58.0	90.0	3.6

If a series of fats containing predominantly long chain fatty acids is arranged according to iodine value, there appears to be a definite relationship between absorption and unsaturation,

the unsaturated fats being more readily absorbed. It has often been suggested that the higher percentage absorption of short chain fats is due to a property they possess in common, a low melting point.

The same investigators have made studies on fat-free diets and have shown that endogenous fat excretion is comparatively small, and that dilution with this appears to be a very inadequate explanation of the lower iodine value of the fecal fat. A second possibility, saturation during passage through the intestine, was also tested out in the comparison between pure triolein and the corn oil-butter fat mixture, with an identical iodine value. If the double bonds are saturated during passage through the intestine, one would expect to find in both sets of experiments that an identical lowering of the iodine value occurred; whereas if there is no appreciable saturation during passage through the intestine, the stool residue on the pure olein diet should still consist of olein, and no appreciable drop in iodine value should occur. One must conclude that the more saturated character of the fecal fat on mixed fat diets is due to selective absorption of unsaturated acid. A marked contrast in the two different diets is therefore shown. On the pure olein diet, the iodine value of the fecal lipoids is only slightly less than that of the food; whereas on the mixed fat diet there is a marked drop in iodine value, indicating that selective absorption is responsible for the greater part of the reduction in iodine value on such diets.

Data were next obtained on the retention by normal infants of particular animal and vegetable fats and various proprietary fat mixtures employed for infant feeding. It was found that certain of the olein rich vegetable fats, especially pure triolein, gave notably a higher absorption value than butter or even breast milk fat. All the commercial fats designed as breast milk fat substitutes are absorbed about as well as butter fat.[34]

FAT METABOLISM IN INFANCY

In answering the question, "Is fat a necessary constituent of the child's diet?" a reason is provided for discussing studies on fat metabolism in infants. Holt, Tidwell, and Kirk have given a scope to their investigations which is most significant. They attempted to compare different fats, both as to their facility of assimilation by infants and as to their fate after absorption. Standard basal feedings of fat-free milk were employed, in which the various fats used were incorporated by homogenization, all

feedings being autoclaved and the vitamins supplied independently. The effect of minerals on fat retention was studied at three levels of mineral intake. The fat was incorporated in fat-free breast milk to afford a low mineral intake, in fat-free cows' milk, and again in fat-free cows' milk to which a salt mixture was added, thereby approximately doubling the concentration of each mineral ingredient. The following tables, made from their experiments both with butter fat and with breast milk fat, are therefore of interest.[34]

BUTTER FAT

	Number of Experiments	Percentage of Fat Intake Retained, Average
Low ash diet (skimmed breast milk base).......	2	94.8
Medium ash diet (skimmed cows' milk base)....	20	89.7
High ash diet (skimmed cows' milk base, plus mineral)................................	3	81.4

BREAST MILK FAT

	Number of Experiments	Percentage of Fat Intake Retained, Average
Low ash diet................................	2	96.9
Medium ash diet............................	5	94.4

THE NEED OF FAT IN THE CHILDS' DIET

It is not our wish to criticize the work of Osborne and Mendel, who conducted experiments showing the effects of fat-free diets on the growth of experimental animals, and arrived at the conclusion that fats were not essential to the diet. Many scientists however have not accepted their conclusions.[32]

Roy speaks of inert fat, that which is stored in the body, as unfit for vital purposes. It is difficult to see that any food product in nature does not serve its part normally as a biologic necessity. Much publicity has been given to the higher nutritive values of butter and certain other commonly used animal fats, since 1912, but apparently lard and the vegetable oils have been ig-

nored because of the presence of vitamin A in the former and not in the latter. However, we believe that this latter group does possess certain peculiar nutritive values possibly not possessed by the former. From a clinical point of view, fats seem to add a satisfying quality to the child's dietary, for when they are given in too small quantities hunger becomes insistent and persistent, the result undoubtedly of an over-consumption of carbohydrates.

Burr and Burr have provided a clearly defined scientific demonstration of the need for including in the diet certain unsaturated fatty acids not found in butter or in hydrogenated oils. Though not clinically proven, it may be that these inactive fats, now listed as valueless in nutrition, play a particular role in metabolism.

The work of these investigators has shown that the deficiency effects of long-continued use of diets devoid of fat are due to the deprivation of one or more of the unsaturated fatty acids. By assigning these vegetable oils to their proper but long-neglected position in the nutritional world, they may be surveyed with broader understanding. In this connection we find that poppy seed and olive oils are somewhat comparable to corn, peanut, and cotton seed oils. Linseed oil is rich in both linolic and linolenic acid, and may be given to children in combination with barley sugar. Cod liver oil contains linolic and linolenic acids, as well as other acids of a still higher degree of unsaturation. Combined with these acids, and with the antirachitic vitamin, cod liver oil stands out as a strong, nutritive weapon against disease. Now the value of these fats, as curative agents and as factors in metabolism for children deprived of a normal quantity of them, is proportional to the amounts of linolic and linolenic acids which they contain. Pictures of starving East Indian children show disheartening effects of fat and other nutrient deficiencies. One may be surprised to hear that cocoanut oil, as well as hydrogenated vegetable oils, such as are commonly used in place of lard and butter, are wholly ineffective as curative agents, regardless of the amounts fed. Incidentally, we have observed clinically that children whose fat storage is very low have suffered from a peculiar malnutritional form of anemia which responded very quickly to treatment with cod liver oil, which oil, however, proved totally ineffective in other forms of the disease. Unquestionably, evidence exists that the long-continued deprivation of these essential fatty acids in the child's dietary affects growth, reproduction, water exchange, and kidney function, and in many cases ends in organic weakness or in death.[35]

TOLERANCE FOR HIGH CARBOHYDRATE AND HIGH FAT DIETS

In eliminating these unsaturated acids from the child's food, he question may arise as to how the organism metabolizes fats nd carbohydrates when unwisely given in excess for the promo-ion of growth. We have often been criticized when suggesting larger amount of carbohydrates and fats in the diet of the ealthy child than many students of metabolism would deem vise. With the normal child, one free from the taint of inherited ysfunction, while the degree of tolerance for these two nutrients s uncertain and different in each individual, tolerance for large mounts of them is certainly present. There is always a possi-ility, however, that these high percentages, even in normal hildren, may at times create a temporary intolerance; but with well-balanced ration and suitable environmental factors this ntolerance is soon transformed to tolerance.

The work of Greisheimer and his associates may prove of nterest. During the course of a study of glucose tolerance in he relatives of diabetics, these observers became interested in etermining the effects of the various diets on glucose tolerance.)ne of this group served as a subject. Weighed diets of known aloric percentages were used. The diet for the first seven days vas a balanced one, that for the second seven days was high in arbohydrates with an average of more than ninety percent of he total caloric intake. Again, the balanced diet was used for he third seven-day period, but the diet for the fourth period vas high in fat. Acetonuria developed from the fourth day on. The diet for the fifth period was again a balanced one. The onclusions showed that the glucose tolerance was not signifi-antly altered by a very high carbohydrate intake over a period f seven days. After seven days on a high fat diet the response o the glucose tolerance test was typical of diabetes mellitus, but he tolerance rapidity assumed its normal proportions after the ubjects returned to a balanced diet. It should be borne in nind when feeding children that not only proper diet but also nvironmental agencies markedly influence liver tolerance for ats. It is obvious that the urea nitrogen and the total non-rotein nitrogen vary to a considerable degree with different lietary conditions. The fasting blood sugar is influenced largely y a diet low in carbohydrates, but a high intake of carbohydrates eems to be without effect.[36]

THE ABSORPTION OF FATS

The exact manner in which fats are absorbed from the alimentary canal has long been a matter of speculation. In normal children with sound digestion and adequate assimilation, absorption is biologic. It is only in those children who have inherited digestive dysfunctions that it is unbiologic. Many of such cases are extremely puzzling and one has often to turn to research, clinical data, and to symptomatology for aid. Often in perplexity one may ask himself, "Are fats absorbed in the form of soaps as Pfluger suggests, or are they taken into the body as a fine emulsion in the formation of which the bile salts play a dominant role, as Munk would have us believe?" The question at issue, then, is whether fats which are insoluble in water are changed into water-soluble soaps and glycerin and then absorbed as such, or whether they enter the villous epithelium as fine globules of neutral fat. The correct answer to this question might help in the study of obscure disease conditions of the gastro-intestinal tract. Pfluger maintains that fat is hydrolyzed by the lipase of the pancreatic and intestinal secretions. The insoluble fatty acids thus set free unite with the alkali of the pancreatic juice to form soaps. These being soluble in water can readily diffuse into the tipthelium. The work of Neuberg shows the influence of the bile salts on these fatty acids, for any inactivity of the liver would hinder the absorption and consequent proper metabolism of the fatty acids of the vegetable oils.

It is often wise, therefore, to omit the feeding of vegetable oils or other fats to children with faulty liver function until the diet has in other respects been more carefully balanced. Under such circumstances, a small amount of boiled or broiled liver, preferably chicken liver, may be successfully added to the diet of children to assist in liver cell reorganization. The fate of fat in the body we believe to be a profound mystery. The need of it is ever seen, symptomatically. Neutral fat is found in the lymph stream, but how it gets there from the interior of the epithelial cells or into the fat depots from the blood stream and back again when it is being mobilized, is almost entirely unknown. It is well understood, however, that during starvation, as well as during fat absorption, the blood becomes laden with fat because of this transference. It is also possible that the lipoids of the cell membrane play some part in this passage. A large portion of the absorbed fat passes directly into the lacteals, but the method of the transport of the remainder is not known. It is believed that the pancreas not only influences the intermediary

netabolism of fat and also that of carbohydrates, but also produces a direct effect on absorption. Disturbances of fat absorpion in many instances may be laid to a deficiency of vitamins A and B. In brief, the mechanism of the absorption of fat is comolicated and depends on the reaction of the intestinal contents, on the formation of hydrotropic substances, as well as on their iction in bringing the insoluble fatty acids into solution and in altering the permeability of the epithelial cells.[37]

FAT EXCRETION

In attempting to balance metabolism in many obscure condiions such as celiac and Hirschsprung's disease, by means of food ats, it is well to have a clear idea as to how these particular ats are digested and metabolized; in other words, how they are olerated by the child. Clinically this knowledge may be obtained o some extent by a macroscopic and microscopic examination of the stools. Often this survey is very valuable in cases of inherited or somatic dysfunctions and may go far in determining he etiology of the condition. The feces of animals normally contain some fatty material which consists mainly of fatty acids with their salts or soaps and a smaller amount of cholesterol and ts derivatives, plus a little fat. The fatty acids and fats are generally assumed to be unabsorbed residues of the fat of the ood, and a food fat is said to be well or poorly absorbed according to whether the amount of the fatty substance recoverable from the feces is relatively small or large. In some cases, and especially when the amount is large, there is little doubt hat this assumption is approximately correct and that the fat and fatty acids found represent largely unabsorbed food fat. However, there is also considerable evidence to indicate that in many instances, perhaps in most, the feces fat has no direct relationship to the fat of the ingested food, but represents, rather, some form of excretion from the intestinal tract.

Frederick Muller, in his studies of the feces fat of two proessional fasters, Cetti and Breithaupt, found that in the case of Cetti the fatty material of the fasting feces was about thirty-six percent of the dry material; thirty-nine percent fat, forty-five percent fatty acids, and sixteen percent cholesterol. In the case of Breithaupt the fatty material composed twenty-eight percent of the dry matter, and of this, neutral fat and cholesterol formed orty-seven percent, and fatty acids and soaps fifty-three percent. The percentage of lipoid material in the feces during the food period differed but little from that of the fasting period, although

the proportion of fatty acids and soap was relatively higher during the food period. Also, since the amount of feces was greater, the absolute amount of lipoid material excreted during the feeding period proved greater than that during the time of fasting. This lipoid material is a fat-like substance but is not necessarily related to the fats, and it does not form soaps with the alkalis and may be of cellular origin. Both lecithin and cholesterol are lipoids. Muller believed that this lipoid substance originates as an excretion of the intestines and pancreas. The addition of small amounts of fat to a test diet affected the lipoid content of the feces but slightly, while larger amounts increased the output. Hermann isolated loops of intestine and found that they were filled up in the course of three to four weeks with a material which was very similar to the feces. An examination of this substance by Ehren demonstrated the presence of fats, soaps, and cholesterol. These results seem to indicate that much fatty material is contained in the intestine and feces which is entirely independent of the food ingested.

It is plain, therefore, that the fat contained in the food has some influence on the feces fat, but seemingly its affects are not great, especially when the amounts of fat fed at meals are not large. In prescribing food fats it is well to remember that the melting point of the feces fat is relatively constant. However, it is consistently lower on the fat diets than on either the fat free diet or on the meat rations diet, which admittedly shows the influence of the fat of the diet on the feces fat. The melting point of the feces fat is almost always below body temperature. Finally, results tend to show that fat is to be found in the feces whether or not it has been present in the food, also that the fat of the food increases the feces fat, but only to a limited extent. The extent of the utilization of food fat is a feeding problem of a different kind, but in any case the amount and kind of fat which appears in the feces and which is independent of the ingested food must be taken into consideration.[38]

ANEMIA AND BUTTER FAT

Under normal conditions a diet rather high in fat affects both blood formation and blood destruction. This conclusion does not seem to hold good in those infants and children who inherit severe dysfunctions. There exists, nevertheless, a great deal of uncertainty as to this formation and destruction. The theory that the blood-forming organs may be harmfully affected

by an over-abundance of fat and of fatty acids derived especially from milk or from its products, can be supported, we believe, by the prevalence of anemia, often of pernicious anemia, in those localities where the dairy industry and the consumption of dairy products hold prominent positions. Obviously this is true only in part. Within the shadow of the Alps and in the valleys, the freshness and ruggedness of the children attract attention. They live largely on dairy products, but their metabolism is balanced admittedly, more or less, by other nutrients. Farther up on the mountainside, where children are restricted in a large extent to the milk of cows and goats, they often appear pale, perhaps pasty, and less vigorous. Czerny claims that injurious agents present in milk produce anemia in infants. These agents are the fatty acids, which cause an increase of blood destruction, an improvement taking place as soon as the milk is limited. Whole milk, while being a perfectly blended food composition, contains only a small quantity of solids in comparison with its high water content. Modified milks have even less solid matter and more water.

Milk is lacking in iron, in the necessary amounts of nutrients, and in vitamins of correct proportions, as well as in the necessary percentages of the inorganic salts, which makes an exclusive milk diet more of a disadvantage than an advantage in nutrition.[39]

FATS AND LIVER FUNCTION

Many physicians have lived through epochs of high and low fat-feeding in infant milk modifications, each school challenging the other. Apparently the question of inherited normal organic or abnormal digestive function was not considered at all. Certainly many healthy children suffer from no excess of fat in their foods, for they completely burn it up. Other children of less favored heritage suffer from excessive amounts. Previous mistakes in treating infants and children suffering from inherited dysfunctions or from certain somatic disturbances because of the presence of large quantities of butter fat or vegetable oils in their diet have necessitated further study. It has been found that often too heavy cream mixtures in infant feeding upset metabolism. Fat metabolism, particularly as it concerns liver function, is an important aspect of nutrition.

We are concerned not only with the fate of the true fats, these being the glycerides of the fatty acids, but also with a curious

variety of substances which are known to accompany these glycerides in natural foodstuffs, and which a few years ago were almost completely ignored. These are cholesterol and phytosterol. No natural oil or fat is composed solely of the glycerides, for all contain a proportion of other compounds as well. Some of these occur as ester combinations with the fatty acids, as, for instance, the higher alcohols, sterols, and other hydroxyl-containing substances; still others are believed to be uncombined hydrocarbons, carotenelike pigments, etc. On complete saponification of an oil or fat, these substances can be separated from the soaps, and together constitute what is usually referred to as the "unsaponitable" matter. This fraction is rarely less than one, and may constitute more than eight percent of the fat-like material present in the organ.

Another aspect of the changes which fatty substances undergo in the tissues and which also cannot be disassociated from a study of the metabolism of true fats, concerns cellular fat, a constant element in biology. It is probably true that the intrinsic tissue fat, that substance which forms an essential part of the cellular structure and which is so necessary to the cell of the growing child, contains few or no simple glycerides; for it is composed largely of phosphatides and sterols, either free or as esters combined with the fatty acids, and probably exists in the cells as organized molecular layers which form not only an integral part of the cell membrane but probably the internal structure as well.

Munk taught that the absorbed glycerides may, in part, be laid down in reserve depots which alter appreciably the character of the stored fat, or they may be oxidized as a source of energy. Finally, oxidation takes place when butyric acid, the acetone bodies, or carbon dioxide and water are produced. Drummond challenges this over-forty-year belief, and cites the work of Mellanby, which provides strong evidence that the hydrolysis of fats is not an essential preliminary to absorption and that probably the amount of lipase secreted in the pancreatic juice is so small that its function can provide only sufficient soap to facilitate the emulsification of the main bulk of the fat.

Not only is there a growing tendency to believe that particularized absorption occurs, but the theory that fatty substances can gain direct access to the portal circulation is one which must be accepted. The necessity of fat metabolism in the child as an aid to normal liver function is seen in the all-important function of the bile to facilitate the absorption of fatty sub-

tances by the formation of these curious complexes with the bile cids which almost invariably show a higher solubility in water han in the parent compound. Three or more of the vitamins re essential constituents of that "unsaponitable" matter and the bsorption of these fat-soluble bodies is of vital importance.

What then is the fate of the absorbed fats and of the accompanying fatty substances ingested in the child's food? We beieve that it can be truly said that the character of the stored fat nay be influenced by that fat which is absorbed from the food. t is highly possible too that the liver selects from the child's liet certain unsaturated acids, such as linoleic and linolenic cids, which are intimately concerned with growth building.[39]

FATS ACT AS A BRIDGE

Bartmann found that when fat was given to the extent of one hundred and fifty percent of the energy requirement it was easily bsorbed and that it spared the protein to a maximum of seven percent. He observed also that when much fat was given in the ood there was an increased elimination of nitrogen in the stools. However, it is known that if a large amount of fat is ingested by healthy children it is burned up in the production of heat and loes not draw on the body fat, while at the same time the amount of protein consumed remains the same. In our experience with pecific digestive disturbances in infants, we have found that ats may act as a bridge to maintain life until nutrition tends to become normal.[40]

VEGETABLE OILS AND FATS

Edible vegetable oils and fats are derived in great abundance from the seeds of plants. They are valuable in the child's organism, for they produce both heat and energy. However, in the dietary of many children the use of these vegetable oils is unwisely restricted to the frying of foods. Under such circumstances the oils are difficult of digestion, because they act as a barrier to the penetration of the digestive juices in the intestinal tract. The beneficial effects of any particular vegetable oil may be largely influenced by the child's psyche, habits, tastes, and environment, as well as by the attractiveness of the foods with which the oil is combined. Indeed, among many groups of children there is found a great divergence of tastes; one child liking palm oil, others preferring cocoanut, sesame, ground nut, almond, or olive oil. Still others are known to enjoy the anils processed

from the kernels of the apricot and peach, which, in a small measure, possess medicinal properties.[32]

Therefore, the question of what oil to use in the child's dietary depends to a great extent on the nose, eyes, or tongue, as well as on the parents' pocketbook. Whether it be olive oil, cotton seed, cocoanut, peanut, or corn oil, there will be found different grades and purity. All these vegetable oils have essentially the same chemical composition and digestibility, the olive oil probably ranking the highest, as it undergoes less chemical change in its manufacture. Children are likewise apt to digest better an oil which they prefer than one that they do not. Indeed, every country, every race of peoples favor an oil grown in their own native habitat, and which, in other countries, is usually easily procurable and cheap in price. The younger generation, following the food habits of the older groups, develop a taste for the same particular oil enjoyed by their parents.

For example, Italians living in other countries, though often free from the contacts, habits, language, and environment of people of their own race, still retain their belief in the nutritive, healing, and satisfying qualities of olive oil. Many people enjoy the flavor of foods cooked with vegetable oils rather than those prepared with butter or lard. The different grades of olive oil are many, reaching from the finest to the lowest. The flavor of olive oil is dependent on the variety of tree, the stage of growth at which the olives are gathered, and on the methods used for separating the oil from the pulp. The finest grade, which is expensive, is made from selected fruit pressed by hand between cloths. The pressed-out oil is then washed in water to remove impurities, decanted from the aqueous layer and sold under the name of virgin oil. The purest of olive oils at low temperature, will yield stearin in rather large amounts. This product consists chiefly of palmitin, stearin, and olein, but it contains much less stearin than do the ordinary solid fats. In the cotton seed, in the sesame, and in other seed oils eaten as food, the quantities of palmitin and stearin are still less, and together with large quantities of olein, contain considerable amounts of linolein. Some of the commoner and cheaper oils will be briefly discussed.

COTTON SEED OIL

This oil is often employed as a substitute for olive oil, but in its crude, unrefined state it is not suitable for human consumption. Although possessing a pleasing nutty flavor, the oil

contains coloring matter and other foreign substances such as albuminous bodies and free fatty acids. After refining it is often bleached and deodorized, the acids being neutralized, and both they and the major portion of the coloring matter removed. The margarines are largely made from this oil.

PEANUT OIL

Another high grade edible oil is that made from the peanut. Unfortunately at present writing there is little demand for it.

CORN OIL

Still another cheap and nutritious oil which is rapidly coming to the front, is corn oil, but it is sold under several names and aliases. Its source is the small germ-portion of the common Indian corn and it can be readily utilized both as a table and a cooking fat.

OIL AND BUTTER

In choosing an edible fat for a given child, one is often called upon to make a distinction between an oil and a butter, which is one of degree and is dependent on certain temperatures. Fats and butters become oils when melted, and conversely, oils become butters when solidified. It must not be forgotten when administering fat alone for any particular reason and in large amounts, that it cannot be given over an extended time, as it cannot sustain life, for in its use there is a constant loss of tissue protein from the body which finally weakens the organ.

SOLID FATS AS FOODS

The solid edible fats which are generally consumed as foods are the milk butters, margarines, and the nut butters.

BUTTERS

Butter fats are sensitive creations which are liable to develop very unpleasant odors and flavors even when they are stored at temperatures as low as 10° Fahrenheit, the amount of change increasing with the degree of acidity of the cream from which the butter was made. Simmons and Mitchell have shown that when butter was made from sterilized cream and then acidified with various acids there followed a gradual development of

unpleasant flavors, which showed that the lactic acid bacteria exerted a marked influence in bringing about the slow decomposition of the unstable compounds in the butter. While butters made from sweet sterilized cream show undeniably less tendency to change in storage than when made in the ordinary way, their flavor usually proves too insipid for the taste. The average composition of milk butter may vary in taste and flavor according to the methods used in its manufacture, in the breed and health of the cow, and in the kind of fodder given to the cow, but within certain limits the goodness of the product may be controlled more or less by the butter makers. For want of a better standardization, the composition of butter may be considered as eighty-five percent of fat, one percent of casein, three percent of salt, and eleven percent of water. The percentage of fat in good butter should not fall below eighty percent, nor should the water content rise above fifteen percent, while the percentage of casein should not exceed four percent. Very often the percentage of fat in good butter may rise to eighty-six or to eighty-eight percent.

CALORIC VALUE OF BUTTER

The caloric value of butter fat is very high, and of the oleomargarines is almost equally so. In fact, one tablespoonful of butter fat yields one hundred to one hundred and nine calories, while a similar amount of oleomargarine gives a percentage of one hundred calories or over.

RESEARCH AND DEDUCTIONS

BUTTER

Briefly, the quality of a milk butter prescribed in the nutrition of children should be judged by its tempting flavor, its texture, color, and the amount of salt which is present in it, as well as by its general appearance. The adoption of the unsalted variety, a European idea, has many advantages. It is better liked, often more digestible, and reactions such as the irritation of the tubules of the kidney by the salted product are avoided. In general, the bouquet of good butter may be said to play a distinct role in its desirability. The texture depends on the granular condition of the fats. The inquisitive housewife may test this texture by drawing a knife blade through it. If no particles of fat adhere, its texture may be considered of the best.

Milk butter contains, incidentally, more butyrin and less stearin than other fats. It is a curious fact that certain feeds for cows, as for instance gluten meal, tend to increase olein in the butter, while beets and other roots have just the opposite effect. The composition of butter also varies with the seasons, reaching its lowest point in October and then rising steadily until it reaches the maximum in March, at which period it holds its own until July, when it gradually drops again.

Stable feeding often gives to butter a whitish or faint yellow color resembling the margarines. Meadow feeding, on the contrary, gives a distinctly yellowish color. To preserve butter, it should be stored in a cool, dark, unheated place, for when good fresh butter is subjected to high temperatures there may develop free fatty acids, which, in excess, tend to irritate the mucous membrane of a sensitive stomach. Usually, however, a very weak stomach will tolerate at least a small quantity of fresh, pure, unsalted butter. Farmers tell us that the milk from Jersey and Guernsey cows produces cream and butter which are more easily digested than those of the milk of the Ayrshire and Holstein breeds. They also remind us that the fat globules decrease in size as the lactation period advances, so that the milk from young milch cows will cream more readily than that of cows far advanced in lactation.[41]

BUTTER SUBSTITUTES

OLEOMARGARINE

The word oleomargarine may conjure up in the minds of the misinformed a product evolved from the refuse of garbage pails and food dumps. This idea, however, is erroneous. The name, oleomargarine, may be applied to any fatty substance prepared for use as butter. Its constituents comprise all substances known as oleomargarine:—oleo, oil, lardine, suine, as well as admixtures and compounds. It includes also all lard, simple extracts, and tallow extracts, all admixtures of tallow, beef fat, suet lard, lard oil, and vegetable oil. Therefore the clinician is called upon to specify the particular kind or brand which he desires to use and the manufacture of oleomargarine is safeguarded by the United States Internal Revenue Office. Compounded by Mege, a French chemist in 1870, the original basis of the product was the soft beef fat from freshly killed beeves. As now made by responsible manufacturers, it is both a clean and wholesome food, attractive alike to the sight and taste, and is greatly to

be preferred to much of the butter sold in the poorer districts.

H. W. Wiley once testified that the beef fat of oleomargarine had a slightly higher heat value than butter fat, but the latter, he agreed, was rather more digestible. Adolph Mayer and, later, Makienzel showed that while ninety-seven percent of the natural butter was digested, the digestibility of the artificial product was only about 0.7 percent less. Among the thrifty inhabitants in France, butter and oleomargarine are considered to be on a par, and in many instances are mixed together, which obviously leads to deception.

Arnold Lorand believed that if the animal fats were of good quality the artificial butter was just as good as butter fat. The unreasonable prejudice of an ignorant parent has often been the basis of the child's antipathy toward the margarines. The objection to their use is acquired, rarely natural, just as the taste for them is selective. Today the margarines are made from undigested fat plus the addition of a certain proportion of vegetable oil, such as cotton seed, olive, palm nut, and cocoanut. Glycerine is sometimes added to give to the product that peculiar glossy appearance, while sugar and glucose may be included to sweeten it. There is usually no better method, we believe, of administering these oils to growing children.

NUT BUTTERS

In the dietary of children, nut butters have never been accorded the position which they certainly deserve. Nuts in themselves possess high nutritive value because, bulk for bulk, they contain more fat than many vegetables. Nut butters are more economical than milk butters or even the margarines, and this is particularly true of peanut butter. A certain chain of restaurants in New York has long featured peanut butter sandwiches. Much as the butter fats and margarines are affected by certain physical conditions, so are the nut butters; for their flavor is dependent on certain oils or on specific flavoring bodies.

From a standpoint of nutrient value, the pecan nut is probably the richest in fat, 70.7 percent, but the Brazil nut, butter nut, filbert, hickory nut, walnut, and pine nut follow closely, with approximately 60 percent. Briefly, to make nut butters, nuts are pounded with a pestle until the mass is of thick creamy consistency, then strained through two layers of clean, boiled muslin cloth or through a fine-meshed wire sieve to remove any lumps. The result is a food attractive to young and old. Added to fruits and to fruit and vegetable salads, these butters provide

a nutritious meal. In reality, these nut butters, unless mixed with the stearins, should be considered nut oils. Manufacturers often add other fats to them, which tends to produce a substance of greater weight and consistency, and they may color the mass with certain harmless vegetable dyes, when it resembles the natural milk butter.

NATURAL PROTECTION

Like fruits, milk fats are liable to contamination from bacterial and other sources. In this respect the margarines fare better, and nut butters fare the best of all. Nature has thrown out an impenetrable stockade around the nut kernels, so that if clean methods are employed in their handling and processing no disease can damage them.

DANGERS IN BUTTER FAT

MICROORGANISMS IN MILK BUTTER

The tubercle bacilli probably stand out as the most dreaded of all contaminating and infective agents in milk and its products, and they are easily transferable in raw milk, but, remarkable as it may seem, they soon disappear from the skimmed variety. They thrive also in the cream and sediment. These bacilli have a higher specific gravity than cream but a lower one than milk, so that one might think that they would gravitate away from the cream and leave it free from pollution. This would happen if the cream were a homogenous substance and not an aggregation of small globules, for the bacilli adhere to these globules. Therefore, if there are any bacilli in the milk they will disclose themselves in the cream and later in the butter. In the latter substance these bacteria may be more easily demonstrated than in the original raw milk, owing to their concentration. The same may be said of other milk-carrying bacteria, such as those of scarlet fever, typhoid, diphtheria, and the like. The bacillus coli communis has also been found in milk, as has the cholera bacillus, as pointed out by Laser. When implanted in milk butter, this bacillus has been known to remain alive and virulent for thirty-two days, while the typhoid bacillus has been known to be active from three to four weeks. Gasperini discovered the bacilli of tuberculosis in butter which was one hundred and twenty-eight days old, and a guinea pig inoculated immediately with a piece of it about the size of a pea, died of tuberculosis ninety-seven days after infection.[41]

COCOA AND CHOCOLATE IN THE CHILD'S DIET

Travellers, explorers, soldiers, and others who have in the course of their lives endured great physical hardships, speak enthusiastically of the high fat value of chocolate and cocoa, not only as heat and energy producers but also as sources of protein. In fact, under trying conditions these foods tended to replenish the protein-storage deficiency lost by privation. Europe in general, Switzerland, and the English Isles, in particular, are addicted to the use of chocolate, and their over-indulgence visually displays itself as more or less universal tooth decay. When, however, these fats are used in moderation they form a good source of nutrition. Chocolate is but a paste or cake which is composed of the roasted kernels of the cocoa with other ingredients added, such as sugar, cinnamon, or vanilla. Of cocoa alone there are many varieties in common use; cocoa, nibs, flake cocoa, and cocoa powders.

THE NITROGENOUS VALUE OF COCOA AND CHOCOLATE

The nitrogenous compounds of cocoa have been investigated by Stutzer, who analyzed a sample of cocoa untreated by chemical methods. Theobromine accounted for 16.6 percent of the total nitrogen, ammonia for 1.4 percent, extractives for 6.4 percent and the proteins for 75.9 percent. The protein content of the cocoa was further subdivided on the basis of its solubility by the animal enzymes. On this basis, 44.6 percent of the total nitrogen of the cocoa was present in the form of digestible, and 31.3 percent in the form of indigestible protein. The solubility and digestibility of the nitrogenous compounds contained in the cocoa are important considerations in any determination of the relative worth of cocoa and chocolate as sources of nutrition for children. In 1900, Forster reported the results of the chemical and physiologic investigations of the nitrogen compounds of Dutch cocoa. Of the total nitrogen, 44.5 percent was soluble in water, 15.6 percent was insoluble but was rendered soluble by artificial enzyme action, while 39.9 percent was insoluble in water and indigestible through the action of enzymes. Some five years later, English writers reported in the London Lancet that 33 percent of the nitrogen of the untreated cocoa was soluble in water and sixty-eight percent was made digestible by the action of pepsin and the pancreatic juices. The conclusions drawn

eem to indicate that a considerable fraction of the nitrogen of hocolate and cocoa exists in a non-protein form and mainly as heobromine, and that a large share of the protein cannot be brought into solution by the animal enzymes. The indigestibility of much of the nitrogen of cocoa is further confirmed by animal experimentation.

Schlesinger quotes the digestion experiments of Weigmann on himself to show that only forty-two percent of the nitrogen of cocoa is absorbed. In 1895, Cohn also determined the digestibility of cocoa nitrogen by experiments *in vitro* and also by digestion tests on human subjects. He found that gastric and pancreatic digestion tests *in vitro* dissolved about fifty-three percent of the nitrogen of cocoa powder. When cocoa was included in a mixed diet of human subjects it was estimated that fifty-three percent of its nitrogen remained undigested. On the other hand, Forster reports human digestion experiments by Bruns which he interpreted to mean that eighty percent of the nitrogen of cocoa is digestible and digested when consumed in milk. Both authors found that the nitrogen of cocoa possessed an average coefficient of digestibility of thirty-eight. The average true digestibility of a mixture of milk and cocoa nitrogen in the ratio of one to one proved to be sixty-three. Assuming the true digestibility of milk nitrogen to be one hundred and that of cocoa nitrogen to be thirty-eight, the expected digestibility of a mixture of the two in equal amounts would be sixty-nine. If the digestibility of milk nitrogen be taken at ninety-five instead of at one hundred, the estimate would be reduced to sixty-six. Cocoa, with an average crude protein content of twenty-one and five tenths percent, should, according to these investigations, contain eight and two tenths percent of digestible crude protein and only three percent of "net" proteins available for replenishing and enlarging the protein content of the animal body.

Evidently cocoa should be classed as an unimportant protein but as an important fat food. The same thing applies even in greater force to chocolate, which contains even a smaller percentage of crude proteins than cocoa.

The following charts, compiled by English and American authors, give the average percentage compositions of cocoa of both the English and American varieties.

THE PRODUCTION OF FAT FROM PROTEIN

With a fat deficiency of the organism, there occurs a somewhat paradoxical, but in reality a biologic transformation of fat from

REPORTED AVERAGE ANALYSES OF COCOA IN AMERICA AND ENGLAND[42]

	American Analyses	English Analyses
Moisture	6.23	3.0– 8.0
Protein	18.34	19.0–20.0 (Nx 6.3)
Fat	26.69	26.0–31.0
Ash	5.49	3.9– 8.8
Starch	11.14	2.7– 7.3
Fibre	4.48	6.8– 7.2
Theobromine	1.15	1.7– 2.0
Caffeine	0.16	
Other N. free substances	26.32	29.0–31.0

AVERAGE COMPOSITION OF COCOA[7]

ENGLISH ANALYSES		
	Dr. J. A. Wanklyn	Dr. J. Muter
Cocoa butter	50.0	42.94
Theobromine	1.50	0.90
Starch	10.00	19.03
Albumin, film, gluten	18.00	12.21
Gum	8.00	6.40
Coloring matter	2.60	3.69
Water	6.00	5.89
Ash	3.60	2.90
Loss, etc.	0.30	
Cellulose		5.95

protein. We believe, however, that this conversion exerts an undue strain on the organism in its output of energy and tends to further weaken the body already exhausted from fat deprivation. Atkinson, Rapport, and Lusk made nutritional experiments on a dog after the administration of 1.200 grams of meat and showed that fourteen hours after the ingestion of this large amount less carbon was eliminated in the respiration than the amount which corresponded to the protein metabolism at the time and as measured by the excretion of the nitrogen in the urine. That carbon was retained in the form of glycogen, was proved by the fact that the quantity of the oxygen which was absorbed agreed with this hypothesis and that the heat calculated on the basis of a retention of glycogen corresponded with the heat as measured

by the calorimeter. It was also proved in this experiment that when the glycogen reservoirs of the body are low the ingestion of meat in large quantities results in the deposition of glycogen. It seems evident that the continual ingestion of meat brings about the retention of a pabulum in the body, which consists partly of glycogen and partly of fat. Only when meat is provided in great amounts is fat alone retained. To illustrate, if a child is given a carbohydrate-containing meal in the evening, followed by a large quantity of meat at breakfast, then during the height of this protein digestion the respiratory quotient may indicate a production of fat from protein. Following the long continued ingestion of meat in large amounts, which induces the retention of "deposit protein," the basal metabolism may rise from a previous low level to a higher one, from which it again falls with the gradual elimination of the "deposit protein." The production of fat from protein tends to strain an already overburdened organism which is trying hard to restore a nutrient balance to metabolism.[43]

THE NUTS

Savage tribes apparently recognized more fully than do civilized peoples the value of nuts as foods. However, the reason that nuts occupied such a large place in their diet may be because they were unacquainted with many articles of food which civilized man considers essential to nutrition, and depended entirely on the comparatively few foods which they were able to secure. Today, nuts are usually considered merely as "fillers in" after, rather than as a valuable part of the meal, their nutrient qualities not being fully appreciated.

In general, nuts contain water, protein, fat, sugar, starch, crude fibre, and ash in large proportions. One might almost say that Canada, the United States, and some other countries, as well, were built on nuts, for these articles formed a substantial part of the diet of the pioneers. In the United States, in the Colonial days, hickory nuts, black walnuts, hazel nuts, butternuts, chestnuts or chinkapins, flourished in abundance, but today many of these delicious varieties have either disappeared or find no market. The machine age, the soft food regimen, and the encroachment of towns and villages on agricultural communities have proved fatal to a plentiful supply of the fine flavored black walnuts, butternuts, and hickory nuts.

Nut meats, like most fruits, are protected from outside invasion, being encased in a natural container, and hermetically sealed.

These meats form a highly concentrated food without much waste. For example, the common English walnut contains approximately ninety-five percent of solids and five percent of water, as compared with meat, which may have as high as seventy-five percent of water, or some vegetables which contain ninety percent.

The chief nutrient constituents of nuts are nut protein and nut fat, but a few of the group, notably the peanut, acorn, chestnut, and the Chinese lichi nuts, are high in carbohydrate content. It has often been substantiated that the characteristic protein of the nut is adequate for growth and that its large percentage of fat supplies enough calories for any deficiency. The oilier the nut, the more quickly it becomes rancid, and such nuts had best be stored in a cool place. While many of the nut varieties are low in mineral salts there are some notable exceptions. For example, almonds are rich in iron, phosphorus, and calcium, and peanuts and pecans possess an abundance of phosphorus. While nut protein closely resembles that of meat and fish, it cannot replace the proteins of eggs and milk over a lengthy period. However, where there is a somatic or inherited sensitization to the proteins of meat, fish, or eggs, nut protein with milk may be substituted to great advantage. For children disposed to acidosis a handful of shelled pecan nut meats form a food which is easily digested and assimilated. They may replace the acid-forming foods (meat and egg), and aid in restoring the child's organism to an acid-base balance. Walnuts and pecans are good sources of vitamins A and B, but these vitamins are found in less appreciable quantities in the Brazil nut, the almond, peanut, butternut, and cocoanut.

All varieties of nuts form a welcome addition to fruits, vegetables, cereals, cheese, milk, and other foods in the proper balancing of metabolism. Incidentally, there are still a few individuals who are said to live on an exclusive diet of nuts and fruits, the so-called fructarian diet.

While we cannot fully agree with Graves in her estimate of nuts as desserts, we can credit her with some excellent suggestions for combining nuts with other foods. Vegetables, rice, and nuts may be cooked together in a casserole or made into croquettes or soufflés. Nuts may be attractively combined with fruits and cheese, and also served in salads, etc. It is unthinkable to give whole nut meats to children who are suffering from inflamed gums or from sensitive erupting teeth, for these meats must be chewed well and finely divided to be digestible. Nut meats which have a high starch content, such as the peanut and chestnut,

can be improved and rendered more digestible by being softened through cooking. The nuts most commonly favored in children's nutrition are the peanut, walnut, almond, and pecan. Fortunately, within recent years, nut growers, notably those belonging to the California Association, are taking a great deal of interest in the selective breeding of the many varieties and in the careful handling and merchandising of them. The recognition of the value of nut meats in nutrition is widening in scope, and shelled nut meats, preserved in all kinds of ways, are now sold in stores which make a specialty of them.

In the careful sanitary measures used for removing the meats from the shells, and in the handling and packing of the nut meats, one is reminded of similar measures employed in the handling and transportation of milk.[44] Preserved in vacuum glass jars, the nut meats keep for a long time and can be transported to distant parts of the world without deterioration. As such, they prove excellent accessory foods for long journeys. Professor Jaffa of the California Agricultural Experiment Station, believes that with thorough mastication the protein content of nuts is as easily digested, if not more so, as are the proteins of meat and bread. However, it should be said that it would take seven hundred walnuts to compare in protein value with two to six ounces of beef.

DIGESTIBILITY OF NUTS

Nuts contain a fibrous or cellular stroma which surrounds the oily meat or kernel and which is made up of protein, fat, and starch cells, all enclosed within a hard shell for protection. The greater portion of the cellulose consumed tends to act as a mild irritant on the intestines, but leaves the body in an unchanged form. The nut meat requires the most thorough and careful mastication in order that the digestive secretions may reach all parts of it. Nuts, in consequence of their high fat content, must pass through the pylorus before they can be digested, and a considerable amount of their proteins and fat would be lost without this previous mastication. As only a small percentage of the nut, as compared with meat, is comprised of water, it is possible that this deficiency accounts for the reputed indigestibility of nuts. It is largely because of their valuable fat content that nuts are added to other foodstuffs in nutrition.

DIGESTIBILITY AND INDIGESTIBILITY COMPARED

In very young children, and in those suffering from gross in herited digestive dysfunctions, exhaustive states following nutri tional disturbances, contagious diseases, physical excesses, or emo tional upsets, nuts are contraindicated. Under these condition they tend to cause indigestion, heart-burn, constipation, and nutritional eczemas. On account of their heat-producing quali ties, nut meats should be eaten in the summer in very moderat quantities.[45]

Gibbons believes that uncooked nuts and vegetables neutraliz and absorb the acids of the stomach and thus prevent fermenta tion. Drew adds that nuts do not endanger the organism with protein poisoning, since the gastric juices determine the quan tity of protein they absorb. While unfired protein is wholesom after it is digested and absorbed, cooked and baked legumes and nuts, the author believes, lose their alkaline activity and tend to ferment in the stomach and to decay in the intestines, the ab sorption of their decomposition causing auto-intoxication and constipation. It should be said that the old-fashioned habit o adding salt to nut meats does not make them more digestibl but rather detracts from their flavor.[46]

NUT BUTTER AND NUT MEALS

Fatty matter predominates very largely in the compositior of nuts, and no other vegetable product is so rich in it. Advan tage has been taken of this fact to make from nuts variou preparations which are cheap, nutritious, and efficient substitute for ordinary butter on the table. Nut products are called b many names, as albene, nut butter, nultolene, cocoa butter, and nucoline. The best of the preparations are made from freshl ground or chopped nuts, freed from their chaff, reduced to paste, and then sealed in glass or in earthenware jars. Beside the butters, nuts are commercialized in other forms, such a syrups, combined with powdered sugar or with malt, as almon paste, and in many other ways. Marzipan, an importation fror Europe, is a finely chopped almond composite which is attra tively molded into forms of animals, fruits, vegetable plants, etc and often portrays human likenesses. Nut meats find, also, medicinal field, for as flour or meal (with the exception of th chestnut products which are too rich in carbohydrates), they ma prove beneficial in those rare cases of diabetes in older children.

It has been estimated that probably much less than half an ounce of some of these nut products is sufficient to yield one hundred calories. This means that two Brazil nuts, eight to ten filberts, half a dozen medium-sized pecans, or a dozen fair-sized peanuts would yield this number of calories. The chestnut is the only notable exception, there being required about three times more by weight to obtain one hundred calories. Nuts produce, in calories, what an ordinary gravity cream, obtained from the top of a quart bottle of milk after long standing, might yield.

Peanut flour, after the extraction of the oil, is an excellent supplement to the proteins of wheat. Both the flour and meal of almonds and peanuts have high protein and caloric value and in this respect differ from some of the others. They are both also outstanding in their high phosphorus content, and almonds furnish a large amount of iron. While these products are poor in vitamin A and contain no vitamin C, they resemble the cereals as sources of vitamin B. When one realizes that now-a-days a child may be given as an entirely satisfactory meal—one which requires no cooking but which is adequate in all respects except in vitamin C—a ration of nut meats, whole wheat bread and butter, and dried fruits, with the addition of two or three ounces of orange or pineapple juice, he may begin to comprehend the economic value of modern nutritional science.[48]

Generally speaking, the nut butters and meals should not be recommended before the child is sixteen months old, and not then if he is inclined to be sickly. Cautiously their use is begun by substituting peanut, pecan, or walnut butters for table butters. Occasionally children show a preference for one of these. Butters given at this early age should be of the highest quality and carefully prepared; the kernels should be pounded thoroughly in a nut mill or with a pestle until the mass is of creamy consistency. It is then pressed through two layers of clean, boiled muslin or through a finely-meshed sieve to remove any lumps. The addition of a raw fruit or juice gives the butter a vitamin addition. Older children prefer whole fruits with whole nut meats. It is well when increasing the use of the nut butters to diversify the varieties and not to give any one alone with monotonous regularity. When the child's teeth are fully erupted and his growth normal, the nuts may be ground and pounded but not strained. As the teeth become firm and fixed, the nut meats are added to the meal just as they are withdrawn from the shells. Exceptionally powerful children with large and sound teeth, horse teeth as they are derisively termed, are able to crack the

shells with their teeth. Such a method tends to conserve the teeth even more by strengthening the jaw muscles, and from the intermittent pressure on the roots of the teeth a better blood supply is accorded them.[46] The four nuts which stand out prominently in nutrition, are reasonable in price, and may be bought almost anywhere, are the peanut, pecan, almond, and walnut. A comparison of the nutrient percentage contents of the four may be of interest.[49]

	Water %	Protein	Fat %	Total Carbo-hydrates	Ash %	Fuel Value Per Pound
Peanuts	9.2	25.8	38.6	24.4	2.0	2.560
Pecans	3.0	11.0	71.2	13.3	1.5	3.455
Almonds	4.8	21.0	54.9	17.3	2.0	3.030
Walnuts (California)	2.5	18.4	64.4	13.0	1 7	3.300

Perhaps, as the nutrition of both infants and children is so important and should be so scientific, a detailed description of the role played by each type of nut may prove valuable.

THE PEANUT

Peanuts, munched haphazardly at games, picnics, and outings, are sold on street corners by filthy venders from equally dirty coke ovens. With such a background it is no wonder that the nut is not considered good enough to occupy a prominent position at formal dinners and receptions. Moreover, the peanut is not recognized for its nutritive properties by the majority. Not only is this nut of nutritional value, but it is of commercial interest as well. It is said that Dr. Moton, formerly head of the Tuskegee Institute and a chemist of prominence, was able to extract from the peanut nearly one hundred by-products of commercial importance. The peanut is usually classified as a nut, but it is in reality the fruit of a leguminous plant which is closely allied to the pea and bean. It develops beneath the surface of the ground and botanically bears no relationship to the true nut. After these nuts are gathered they are sorted, and those not selected for the market are converted into peanut butter and oil. The Virginia and Spanish varieties are considered the best for human consumption. The former, or jumbo nut, is larger and of a distinctly individualistic flavor, and possesses a rather low fat content of thirty-nine percent but a high carbohydrate counterpart of twenty-four percent. Its caloric potency is high

at least compared with the meats and cereals, and in sensitized children may well be substituted for them. The shelled nuts, either blanched or salted, and made into pastries and puddings, should be more generally recognized as valuable and nutritious foods. Certain producers are featuring peanut butter as bread spreads, and in a few homes it is served as part of a meal, for in this form the nut is very easily digested.[50] Commercially, the peanut is recognized as having only twenty-five percent of refuse, as compared with the almond which has forty-five percent, the pecan, forty-six per cent, and the California walnut, seventy-three percent.[51]

THE SUPPLEMENTARY PROTEIN VALUE OF PEANUT FLOUR

Recently a number of feeding experiments have been carried out which were especially arranged to observe the protein values. Feeding rations were used which contained various combinations of wheat flour, peanut flour, meat, butter fat, and salts. The results obtained indicated that the peanut flour was slightly superior to meat in producing growth. The same product appears also to promote a higher degree of fertility. The general trend of the findings seemed to point clearly to the fact that the lowly peanut is a real factor in modern scientific nutrition.

THE PECAN

The pecan has the distinctive characteristic of being attractive to the eye, to the palate, and to the public taste, consequently it occupies a prominent position. The meat of this nut is very nutritious and is easily digested. On account of these qualities the pecan enjoys a greater popularity than does the peanut. The choicest varieties are grown in southern Indiana, in Northern Kentucky, and in southern Virginia. The pecan consists largely of three percent water, eleven percent protein, seventy-one and two tenths percent fat, about thirteen and three tenths percent of both starch and sugar and five percent of ash.[45] The paper shell variety is superior to the red hard-shelled nuts, although even among the former are found variations in quality. The meat is not so oily as that of the black walnut, and is therefore a better nutrient for children. Recently a process has been invented which divides the nut meats into very fine pieces, and in this form they are more easily digested and metabolized.[50]

Some idea of the nutritional worth of these nuts may be

realized when one discovers that twelve meats of the shelle pecan weighing 0.5 ounces and fourteen grams give a yield c one hundred calories, five parts protein, eighty-seven of fat, an eight parts of carbohydrate.[51] One may go still further and fin in one cup of shelled pecans weighing 5.5 ounces and 96 grams 11.5 shares of calories, 6.0 of protein, 6.0 of calcium, 11.7 o phosphorus, and 8.0 shares of iron.[48]

THE PECAN AS A SOURCE OF ADEQUATE PROTEIN

Should further proof of the adequacy of nut protein be needed and should clinical human experimentation with nut meats be considered unconclusive, further experimentation on animals under restricted laboratory conditions might prove more satis factory. Cajori observed that young rats would grow at a normal rate and eventually attain adult size on diets in which the essen tial source of protein of the prescribed ration was derived from the various nuts. Following his successful tests, he concluded that the proteins of these nuts furnished suitable amounts of the amino-acids so necessary for growth. On the whole, if we judge correctly, his experiments with the exclusive use of pecan nut meats in these little animals failed, however, whereas in children they might have succeeded. There may have been two reasons for this failure. First, the proteins of the pecan may have yielded insufficient amounts of the amino-acids, which determine the nutritive value of a protein, and second, and possibly a more likely reason, the nut meat used may have contained some sub stance which, allied with the other rations of which it was a component part, was either distasteful or injurious to the rats. Now the pecan nut or its flour contains as its principal protein a globulin which is easily digestible and metabolizable in the child's organism, and which yields large amounts of the basic amino-acids. Children sometimes form a distaste for the shelled nut, as it is bitter and astringent, owing to the large quantity of outside cuticle, but after its removal the pecan is tannin free. While the skin of the almond can be removed completely by bleaching in hot water, this method fails to detach the nut cuticle from the numerous crevices on the wrinkled surface of the pecan. Exposure to hot solutions of sodium hydroxide will, however, loosen it completely.

The great importance of the pecan globulin and of its attend ant amino-acids may be realized from the following table by Cajori.

DISTRIBUTION OF NITROGEN IN PECAN GLOBULIN

After hydrolysing 2.1727 gram of the protein, the solution contained 341.9 mg. of nitrogen.[52]

	Mg.	Percent
Amide N	33.5	9.8
Humin N	12.3	3.6
Arginine N	78.3	22.9
Histidine N	17.7	3.7
Cystine N	2.7	0.8
Lysine N	21.2	6.2
Monoamino N	178.8	51.7
Non-amino N	2.7	0.8
Total	340.2	99.5

THE WALNUT

Cajori, experimenting with rats which consumed six to eight grams of total food per day, found that if the almond, the English walnut, the black walnut, the chestnut, the Brazil nut, or the pecan were included in the general ration to an extent of one to two grams daily, the walnut alone sufficed as the sole source of vitamin B. In brief, the composition of the English walnut is as follows:—

In 14.2 grams by weight there are 1.04 shares of protein, 0.56 shares of calcium, 0.34 shares of phosphorus, and 0.60 shares of iron. Vitamin B is present in large quantity, vitamin A is second, while the presence of vitamin C is questionable.[48] Also it is supplied with a large proportion of protein and fat, about sixty-two percent, the latter amount rendering it less digestible than the pecan, but it has, in contrast, a more marked laxative effect.

Black walnuts are considered a luxury rather than a food and are eaten mostly because of their rich, appealing flavor. Memory may recall the hard, rough, black, shaggy shell of the uncultivated walnut, which, when cracked and eaten before an open fire on a cold winter's eve, provided a treat not soon forgotten. Tea rooms, church socials, and card parties are addicted, so to speak, to both black and English walnuts as ingredients in candy, pastry, and bread.

The oil made from these nuts possesses a delicate, nutty flavor and is much enjoyed in salads and with Chinese vegetables. The English variety is known the world over, and history records that

it was highly esteemed by the ancient Persians, who used the nut as a trading medium to introduce its merits to other countries. The Greeks also proclaimed its use because of its flavor, and the Romans called it the "nut of the gods." The traveller in Turkey may recall with pleasure a concoction called "sujak" or "rojik" which is made by stringing walnut meats on twine, then immersing the whole in a mixture of grape syrup and flour, after which the strung meats are hung up to dry.[50]

Commercially, the English walnut is prepared for the market by removing the meats from the shells, drying them on trays, or treating them artificially by means of heated air.

THE ALMOND

Though all nuts possess valuable nutritive qualities, the almond has always enjoyed a wider range of recognition for its outstanding qualities. It is supplied with nitrogenous matter in a valuable and nutritious form and has the added advantage of being compact and easily transportable, as it is even less subject to deterioration than the peanut. Someone has wisely said that "no man need starve on a journey who has his waistcoat pockets filled with almonds." In its natural state, however, and when dry, the meat is too hard to masticate for tender gums and erupting teeth. The almond is also a rich source of fat, which represents half its weight.[47]

The almond is probably the best known of the nut family, and is native to many countries. Its principal sources are those countries bordering on the Mediterranean, Persia, Palestine, and other Oriental lands, as well as California and Florida, in which countries it is now extensively cultivated. There are two varieties of the almond, the bitter and the sweet. The so-called Jordan almond, an example of the sweet variety, surpasses the other in quality. The bitter kind has a very disagreeable odor and is quite unfit for food. The green almonds are the young sweet nuts before the shell is formed. When preserved in sugar and syrup they make a delicious confection. Almonds contain no starch, their carbohydrate content consisting entirely of sugar, gum, and fibrocellulose. Their fat content, about fifty percent, is found in the bland oil. The fat consists mainly of olein with a small amount of palmitin and stearin. This oil corresponds to olive oil in nutrition but is much more agreeable to children. Eaten purely as nuts or ground into flour and made into almond paste, the almond may represent easily digestible and appetizing nutrients in biscuits, bread, in candies, and in the confection

marzipan. The nut is not only a nutritious food for well children but proves a trustworthy constituent of the diet of diabetic and of ketogenetic children.[45] As with the pecan nut, growers have developed a paper shell variety so thin that it can be cracked between the fingers. It has an advantage over other varieties in that the kernel is larger and contains greater amounts of nutrients; but a disadvantage, as the meat may be invaded by worms and is prone to destruction by birds—conditions which never affect the other forms. Historical works of the early Greek and Roman dynasties mention the use of the almond served with wines and liquors at formal dinners.[50]

Its nutritional importance may be represented in a practical manner, when it is shown that one cupful of shelled almonds of some 4.0 ounces or 118 grams, give a heat output of 734, comprising protein at 95, fat at 560, and carbohydrates at 79. If again, almonds are considered with a given weight value of 15.5 the protein shares prove to be 1.29, the calcium 1.61, the phosphorus 1.64, and lastly the iron 120. The almond not only contains vitamin A but is an excellent source of vitamin B.[48]

HUMAN EXPERIMENTS ON THE UTILIZATION OF THE CALCIUM OF ALMONDS

In general, the Anglo-Saxon child may be said to be calcium-poor, the deficiency growing greater as poverty grows worse and the economic sources of income dwindle. Possibly a more understanding approach to practical nutrition may be made by human rather than by animal experimentation, although the latter is more selective, systematic, and scientific. Calcium, whether of vegetable or animal origin, is the same, for the calcium of one food product is just as utilizable as that of another. No child seems ever to get an excess of it. In the following study on twelve healthy young women, seventy-five percent of calcium used in the diet came from the almond. The daily output was 4.6 mg. of calcium per kilo of body weight on an intake of 4.1 mg. per kilo. This study showed that a calcium equilibrium could be secured about as well with almonds as with milk, as it furnished approximately the same proportion of calcium, or seventy percent. It was found that when almonds furnished 85-86 percent of calcium the amount necessary for equilibrium increased. Blatherwick and Long have shown that on a mixed vegetable diet in which fifty percent of the calcium was derived from vegetables there was an equilibrium of 8-10 mg. per kilo. Strangely enough, the very rich fat content of this 86 percent

almond diet tended to increase the loss of the calcium. Finally, it would appear that while a small calcium percentage of the almond contributes well to the calcium need of the child's diet, a very large proportion of it cannot be as successfully metabolized as when carrots, other vegetables, and milk form the main sources of this salt.[53]

NUT DAINTIES

Children are biologically different, but in a sense hunger and appetite make them akin. For the normal hungry child a handful of shelled nuts has a decided allurement. But a child need not be abnormal to prefer its nut meats served in some other fashion Thus nut meat dainties fill a distinctive need. Whereas the plump and more uniform kernels of the almond, for instance, are served as desserts and candied confections, the broken and less attractive meats are utilized by bakers and others for making bread, pastries, and almond paste. Because of their distinctive flavor, almonds seem to have special food affinities, as when dates and chopped almonds are blended together, a food used by the Bedouin Arabs when on the march. Blanched almonds and candied rose-petals also, when blended, give to the product a delicate exotic fragrance and flavor. Burnt almonds are roasted sweet almonds, and when destined for consumption as in confectionery, cane sugar, maple sugar, and honey may be added to them. The white creamy kernels of the green almonds, soft, fresh, and with the skins removed, make an attractive food when candied or united with honey or syrup. Among the Italian colonies in the large cities there is to be found a refreshing beverage made from almond milk, sometimes called orzata, which is flavored with anise.[50]

A high-grade flavoring syrup for salads, custards, and puddings may be made by mixing the ground kernels of both the bitter and the sweet almonds in the proportion of three to ten with barley syrup or with a concoction of orange flower water and sugar. Almonds, pecans, and walnuts are used extensively in ices, ice creams, and in custards, while almond oil provides an excellent relish for salads. The oil of bitter almonds supplies a tasty flavor to fish and meat. The peanut is generally eaten cooked by either roasting it in the shell or after shelling it. I has been estimated that about twice as many peanuts are roasted after they are shelled than before. The peanut meats are blanched, and salted or used blanched alone when they make u a part of the ingredients of candies, cakes, and pastries, as d

ne almonds. From almond flour, almond pudding or almond iscuits and cakes may be concocted.[54]

If one takes the trouble to examine books on cookery, particuarly foreign publications, he will find such nut meat delicacies s nut roll and nut rissoles.[55] From the same sources he may iscover other dishes, such as cheese and nut loaf, walnut and heat roll, or a lentil nut roast made with peanuts. Nut steak ashioned out of walnut meats, nut and rice croquettes made with rotose, or a nut and vegetable stew are other discoveries he nay make. Frederick mentions one other dish, quite generally nknown, a nut meat pie made of chestnuts which is suggestive f hunger satisfaction and olfactory pleasure. Where the child is uffering from the effects of a too liberal ingestion of meat and ggs these nut dishes may be substituted to great advantage.[56]

THE INORGANIC SALTS

Mineral salts are very important in the nutrition of children, s they largely control the physico-chemical mechanism of the issues, growth, and normal body function. Balanced nutrition s impossible when the diet lacks one or more of these elements. ll cells, tissues, and body fluids contain inorganic salts, which erve to maintain a constant surface tension and osmotic balance o supply the necessary balance of the ions as well as to aid igestion. When the body contains an excess of the salts, only he requisite amounts needed for metabolism are retained, the est being excreted.

When the child's body is wasted from disease, new tissues canot be formed with the mineral salts. The framework of the hild's body contains chiefly phosphates and the carbonates of alcium and magnesium; the body fluids the chlorides and biarbonates of sodium; the cells, the chlorides, bicarbonates, and hosphates of potassium and magnesium. Iodine is an essential onstituent of the thyroid gland and iron of hemoglobin and nuscle cells.

The mineral salts essential in nutrition are the following:—odium, potassium, calcium, magnesium, phosphorus, manganese, ron, copper, iodine, chlorides, zinc, fluorine.[57]

IRON

Experimental work has demonstrated the effectiveness of simple elements in the food of children, rather than those in organic orm. When small amounts of simple iron and copper are ad-

ministered, preferably in food, there takes place an optimum hemoglobin regeneration in the anemias of childhood. Children show inability to utilize in their bodies hematin iron, the so-called organic iron. Probably all food materials contain two forms of iron, one of which reacts to the reagent bipyridine, the other, hematin iron, does not. The value of different foods as sources of iron is dependent directly on their iron-hematin, their inorganic content.[58]

SODIUM

Sodium is contained in many foods. Milk contains a large quantity, cows' milk three times as much as human. Whole milk supplies sufficient of the salt to nourish artificially fed children, and the mother usually supplies enough in her milk for her nursling. Sodium salts are found plentifully in the body fluids, in lymph, blood plasma, cerebrospinal fluid, and in gastric and intestinal secretions. Normal osmotic pressure is helped to be maintained by sodium, together with the chlorides. Combined with bicarbonates and phosphate, there is a maintenance of normal hydrogen-ion concentration and of the acid base balance. Some of the salt is lost in the urine and intestinal secretions, and must be replenished in the ration. The hydrochloric acid of the gastric contents is derived from the sodium chloride of the blood, while the alkaline carbonate of the bile, pancreatic, and intestinal secretions is the product of sodium bicarbonate.

POTASSIUM

Potassium is associated with sodium in many foods. Cow's and human milk contain more of it than of sodium, the former almost twice as much. It has been estimated that potassium requirement for body development is relatively greater for infants and children than for adults, the daily output being 2 grams. Potassium is the chief inorganic constituent of red blood cells and of fixed tissues and is present only in small amounts in the body fluids. Potassium found in the urine represents an excess with residue from cell destruction. An excess of potassium deprives or depletes the body of its sodium by causing the excretion of sodium chloride.[57]

COPPER

Copper is also necessary for hemoglobin formation, iron and opper acting together, and many foods contain at least some opper, although in some there are only small amounts present. ractically all foodstuffs contain both iron and copper, and it well to know the available quantities of these salts in food aterials in treating anemia and malnutrition. Simple anemia common even where malnutrition is not found. Fullerton and ampbell concluded that anemia was present in 41 percent of nfants under 2 years; in 32 percent of preschool children and in percent of school children. Daniels and Wright suggest that iets for children of preschool age should contain not less than .1 mg. of copper per kg. of body weight. These authors believe hat if an infant is born with an inadequate quantity of both lts, or if the body is later depleted by long illness, it is difficult supply a sufficient amount of hemoglobin with food alone.

ZINC

Zinc is an essential element in the nutrition of children. Iany foods contain a reasonable amount. In an experiment on oung rats, Todd, Elvenhjem, and Hart fed a highly purified ation containing the known vitamins and mineral salts, but without zinc, and found the ration inferior as to rate of growth and aximum weight when compared with that in those rats receiving he same ration with the addition of this mineral. Milk contains ore zinc than iron, copper, or manganese, and the body organs, he liver and pancreas, possess very large amounts of it.

FLUORINE

Fluorine is necessary to metabolism, especially in the formation f the enamel of the teeth of growing children. It is widely istributed in the tissues but is especially found in large amounts epidermal tissues. If too highly concentrated it may be strongly oxic. It is stored in the kidney and thyroid gland when administered in large quantity in foodstuffs.

CALCIUM AND PHOSPHORUS

The secretion of certain glands and vitamin D are intimately onnected with the metabolism of calcium and phosphorus.

These salts, integral parts of bones and teeth, phosphorus especially, are also vitally essential in the nuclear structure of every cell. It has been estimated that children have a storage of 100 mg. of calcium and 60 mg. of phosphorus per day. Ninety-eight per cent of calcium and seventy-two percent of phosphorus in the body are found in the bones and teeth. Both minerals are contained in a wide variety of foods.

IODINE

The thyroid gland probably contains about 10 mg. of iodine, and it is very necessary to normal nutrition in children. Probably 50 micrograms should be their daily intake. Visitors in New England rural districts and in other parts of this country and Canada have remarked upon the large number of simple goitres found in farmers' wives and in their young daughters in regions where grains, soil, and water yielded no iodine.[58]

MANGANESE

This salt is widely distributed in animal and vegetable tissues and is important in the nutrition of both children and plants. The liver, kidney, pancreas, lymph nodes, and other organs and tissues contain manganese in varied amounts. In toxic doses it may be poisonous and result in testicular degeneration. The diet for children should probably contain between 0.20 and 0.30 mg. of it daily.

MAGNESIUM

Another element which is highly essential to animal life is magnesium, the greater part of which is contained in the bones. More magnesium than calcium is present in muscle. The amount found in the blood varies between 1-3 mg. per 100 cc. and it is distributed between the plasma and cells. Magnesium is intimately related with the metabolism of calcium and phosphorus in the child's body. In moderate doses it may act as a depressant to motor and sensory activity, and in larger doses as an important sedative and even as an anesthetic. A deficiency may produce marked structural changes in the teeth and in their supporting structures. Clinicians often discover many unaccountable actions in children which apparently rise from a deficiency of magnesium in the diet, such as hyper-irritability of the nervous system, triphi changes, and failures in nutrition. Thirteen mg. per kg. of body

veight is probably the essential requirement for children between he ages of four and seven years. It is widely distributed in foods.

ARSENIC

It is questionable whether arsenic is needed in body function. While largely found in the edible portions of shrimps, it is often liscovered on the surfaces of fruits and vegetables which have been sprayed with it in solution.

ALUMINUM

No evidence exists which proves aluminum necessary in the nutrition of children. It is normally present in small amounts n foodstuffs of animal and vegetable origin, and may be found n foods cooked in an aluminum vessel. It is harmless, however.

THE VITAMINS

A vitamin deficiency disease of whatever nature causes distincive functional disturbances which have their origin in morphoogic changes in certain tissues and which are regarded as prinary effects. Various non-specific and secondary effects necessarily ollow.[59] The vitamins have so impressed themselves on the ttention of nutritionists that they now tend to stand out from other nutrients in bold relief, much as does the mountain from he valley below. This seems rather unfair to all the various ood essentials which are manifestly intended by nature for the balancing of metabolism. Single nutrients cannot perform their llotted tasks without the assistance of other nutrients. Hence he idea of segregating any one of them would seem to be unbiologic. The fact remains, however, that as replenishers in nuritional deficiencies the vitamins are being thrown into the imelight.

It is true the pediatrician seldom sees an extensive avitaminois, being concerned as a rule with deficiencies of a minor degree. Therefore his principal concern is with the vitamins which may overcome these minor deficiencies. It is equally true that avitaminosis does not particularly interest the average mother, but he knowledge of foods that will supply the vitamins essential o the health of her child is of great importance to her. It is for his reason that pediatricians should become familiar with the vitamins and with the foods which contain them.

Often in cases of malnutrition it is extremely difficult to keep

the child on a restricted and uniform diet which contains all th necessary nutrients for his particular needs. It is very importan that the foods be attractive and appetizing, in addition to bein nutritious.

Owing to the existence of various inherited and somatic dys functions, it is impossible to determine accurately what vitamin and what quantities of vitamins the child requires without a more or less extensive knowledge of the child and his environ ment. Clinically, no fixed standards can be adopted, for th child's minimum or maximum vitamin requirements depen upon so many circumstances, such as the time of the year, baro metric changes, and general physical environment. From our ex periences we are led to infer that many children have predilec tions for certain vitamins and not for others. Thus a seemin oversupply of vitamin A, for instance, or of another vitamin alon or in combination with others, apparently invests the child with unprecedented health and vigor.

Scientists are striving hard to establish a balanced nutritio for the greatest good of the greatest number, and to formulat a standardized normal diet which includes the vitamins. This i a hard task, for in reality each child is a law unto himself. Th normal diet for children classed under minor and intermediat dysfunctional cases must of necessity be simple. Generally speak ing, such a diet should provide a not too high caloric content an a not too large quantity of devitaminized foods, such as whit flour, sugar, lard, oil, and many syrups.

As a rule, there should be a minimum amount of meat an eggs and a maximum of milk, cheese, fresh, dried, and canne fruits, green vegetables, salads, and butter fat. The amounts o starchy vegetables, bread, and cereals prescribed should depen largely upon the energy and growth requirement of the chil as judged by his behavior.[1]

In the following pages are described briefly and separatel each vitamin now known, its character and value, and the case in which it replenishes a deficiency; and the foodstuffs wherei it is found are also indicated. All of the vitamins, with the ex ception of vitamin A, find their origin in plant life. Howeve carotin, the precursor of vitamin A, is found in the plant.[59]

VITAMIN A

The lack or loss of vitamin A in the child's organism resul in a general weakness and an inability to resist infection. Th vitamin may be stored in the cell like any other nutrient. It ha

been found that a liberal food intake of vitamin A gives the body an increased resistance to disease. Such an intake provides greater resistance than the same amount of other vitamins. A striking pathologic condition of vitamin A deficiency is the result of an accumulation of keratinized epithelial cells in the glands, in their ducts, and in many organs.[59]

A deficiency of vitamin A is known to produce metaplastic changes in the mucous epithelium. Manville has demonstrated that washings from the conjunctival sac and the urinary sediment have shown an increase in the number of desquamated epithelial cells, evidence that these structures are suffering from a vitamin A deficiency.

The mucosa of the gastro-intestinal tract does not, however, provide so readily evidence of this sort. This tract is exposed to more traumatic injury than any other system having a lining of mucous epithelium. Actual goblet cell counts of comparable areas of entire villi have shown that there is a marked reduction in the number of mucus-secreting elements and an increase in the number of goblet cells, showing reduced activity in vitamin A deficiency. A prosthetic portion of the mucin molecule in glycuronic acid. In vitamin A deficiency, a failure in the production of mucus might be due to an insufficiency of this acid. Two sources of glycuronic acid are available to the body, the one when this acid is synthesized from glycogenic amino-acids and the other when obtained from food materials. A reduction in the amount of mucus exposes the lining of the stomach, pylorus, and large intestine, especially, to injuries produced by the solid components of the food or feces. These will result in capillary bleeding, which in turn will be responsible for blood in the stools. The occurrence of occult blood in the feces is probably the earliest evidence obtainable of a deficiency of vitamin A.[60]

Cod liver oil, and indeed the livers of many fish, contain vitamin A in large amounts, and it can be effectively stored in large quantities for future requirements. Indeed, from this same source vitamins may be supplied over a long period where a deficiency would otherwise result. It appears that vitamin A can be stored in much larger quantities in the body than can vitamins B and C.

It has long been recognized that a breast-fed infant of a healthy, adequately nourished mother has a much greater immunity to disease than the bottle-fed infant. This is probably because of the vitamin A in the mother's milk. In older children, varying amounts of this vitamin are stored from ingested foods. It is

known that the precursor of vitamin A occurs in plants and that this A is found in animals, but its quantitative distribution is extremely uneven. Some foods contain much more than others. Milk is influenced to a large extent by the nutrition of the cow. The food fed to the cow will increase or decrease the vitamin A content of its liver. Eggs too are affected by the feeding and environment of the hens.

The vitamin content of plants, in some instances at least, appears to vary according to their color. In the same head of lettuce it is found that the green outer leaves contain thirty times as much vitamin as the white inner leaves. An exception to this is escarole, which, incidentally, is richer in vitamin A than is spinach. Vegetables more or less rich in vitamin A are escarole, kale, carrots, carrot tops, string beans, green peas, pumpkin, sweet potatoes, yams, tomatoes, lettuce, Brussels sprouts, and spinach. Vitamin A is found, too, in bananas, plantains, cantaloupe, cherries, watermelons, apples, grapes, and pineapples. Most cereals and many of the nuts contain it, exceptions being cornmeal and the pecan nut. Liver is a much utilized source of this vitamin.

Generally speaking, fats and oils, especially those which have been subjected to hydrogenation or intense refining processes, contain no vitamin A; the yolks of eggs and the butter fat of milk are well known sources of vitamin A. Also their various products are excellent replenishers of vitamin A deficiencies. This is not surprising when one considers that the cow and the hen consume large quantities of green foodstuffs, and a readily assimilable form of vitamins, proteins, fats, carbohydrates, and mineral salts is transmitted in their food products.

If the flesh of fish is rated higher than that of land animals it is because the green water plants synthesize the provitamin A as much as do the plants grown on land, if not more. Also, fish is more readily digested than meat. The diatoms, algae, and other tiny aquatic forms create this provitamin in the process of their metabolism. These water plants provided with provitamin A are eaten by small crustacea, which are eaten by fish, and these in turn are eaten by larger fish like the cod or halibut. The great value of cod liver oil lies in the fact that the cod carries almost no fat except the oil in its liver, and this is richly endowed with a high potency, fat-soluble vitamin A.[3]

In considering the source of vitamin A, we must not overlook the correlation between this vitamin and carotin, which is a yellow pigment found in varying amounts in carrots, sweet potatoes, spinach, and other vegetables.

The presence of carotin in foods assures the presence of vitamin A. Many flowers, fruits, and vegetables which are known to contain an abundance of provitamin A are rich in the carotinoid pigments and, in many cases, in chlorophyll. In brief, carotin appears to be closely associated with the formation of vitamin A or of some provitamin in plants. The apricot contains carotin in measurable amounts, and is of exceptional value as a source of vitamin A, for it is extremely rich in carotinoid pigments. That vitamin A and carotin are definitely associated has been confirmed by the conclusions of Morgan and Madsen. Apricots upon which they experimented yielded vitamin A in nearly the same amounts as were indicated by their carotin content when compared with the vitaminic value of similar doses of what is known as crystallin carotin.[61]

VITAMIN B IN GROWTH AND NUTRITION

In speaking of vitamin B, we are immediately reminded of that unfortunate affliction caused by its deficiency, beri-beri. This disease, common in Asia and other Eastern countries, and seasonal in occurrence, is a multiple, peripheral neuritis. Usually it affects both feet and, unless checked, extends progressively up the legs. Infrequently clinicians discover cases of a mild form of beri-beri in this country among orientals congregating in the large foreign communities.

Osborne and Mendel have shown that vitamin B is necessary in the nutrition of mammals, not only for protection from polyneuritis and for the support of growth, but also for the maintenance of the appetite. This means that this vitamin functions not merely to make foods more appetizing, but to promote the appetite as a normal physiologic property of the living organism. In this respect, vitamin B is closely associated with vitamin A.

A child deprived of vitamin B soon loses his appetite, but regains it when the vitamin is restored to the dietary. Clinically, the effects of this deficiency are seen more clearly in older children than in younger ones. Incidentally, it seems to us misguided zeal to prescribe a diet of sugars and starches in excess, or when these are combined with vegetable oils in order to gain high caloric percentages, but at the same time to omit from the dietary foods containing vitamin B. There is always the danger that the child will lose his appetite for foods containing vitamin B in trying to assimilate and metabolize the great bulk of a high caloric intake.

VITAMIN B DEPRIVATION

A too strong protest cannot be made against the subjection of food materials to certain industrial and even household processes which deprive them of their vitamin B content. Over-refining may bring about this result. Vitamin B loss occurs also when the water in which foods have been cooked is thrown away. If foods are being cooked other than in a double boiler, the water in which they have been boiled should be used either in soups or for drinking purposes. The intelligent housewife both cooks and preserves foods by canning so that the natural food elements are not destroyed. Also, the better type of food product organizations preserve fruits without counteracting their natural acidity by the addition of an alkali or by destroying their vitamin content.

With a well-balanced dietary all the food elements are obtained that the system requires. Our ordinary table foods supply stimulants, appetizers, blood producers, sedatives, and growth builders.[3]

VITAMIN G (B_2)

The term vitamin B was formerly used for the whole of the vitamin B complex, rather than vitamin B (B_1) for its heat-labile and vitamin G (B_2) for its heat-stable component. At present there is ample evidence that each of these portions is of a multiple nature.

In spite of a vast amount of experimental work already performed, one should proceed with caution in distinguishing them. Apparently, however, vitamin G (B_2) is the first limiting factor of growth. The first established chemical difference between vitamins B and G is the greater stability of vitamin G.[3]

VITAMIN G IN NUTRITION

The scientific differentation between the vitamins, while interesting, does not concern the clinician as much as does their significance in nutrition. The pediatrician is usually able to observe the efficiency of vitamin G in its influence on the early growth of infants and on the later growth of children.

There is ample reason to believe that vitamin G is a growth essential for human organisms generally, and that it plays a

very important part in nutrition at all ages. With foods containing vitamin G as the only significant nutrient, experiments have given evidence that vitamin G in abundance provided a better growth and development, an extended expectancy of life, and a reduction in the death rate. It is not an idle thought to postulate good health, contentment, and happiness for the child where a rich supply of vitamin G is associated with other food elements in the diet. The combination of vitamin G and calcium in milk make it an important nutritional product. The liberal use of the so-called protective foods tend to preserve and stimulate the daring of youth and the adventurous spirit of adolescence. Indeed, these characteristics may be considered evidence of a generous supply of calcium, phosphorus, inorganic salts, and other nutrients in the diet, fortified by the vitamins A, C, and G.

The edible parts of animals, notably the flesh and liver, may suffer from a deficiency of essential vitamins, for the amounts stored within their cells correspond to the amounts eaten by the animals. For the most part, vitamin G is found in the cereal grains and in seeds, and is bound up in the growth of green plants. However, the amount decreases in proportion to the drying of the plant.[3]

VITAMIN C

This element, generally termed ascorbic acid, is often called the scurvy vitamin, so closely has it come to be associated with the treatment of this disease. It is well to remember that the vitamins are not chemically related to the degree that is usually inferred, and the chemical nature of each vitamin is a problem in itself.

Vitamin C is destroyed when even a fairly moderate temperature is applied to the foods containing it. This loss may take place in the home kitchen or in the large canning factories. Probably it is due, at least in part, to oxidation. Of the amount of vitamin C contained in milk, about one fifth is found to be destroyed when the milk is boiled for five minutes in an open vessel. At higher temperatures the loss proceeds more rapidly, as shown by the fact that commercial "evaporated" milk, which has been preserved by heat sterilization, usually shows no measurable amount of vitamin C, whereas commercial "condensed" milk, which has been concentrated by evaporation in a similar manner, retains a good proportion of the vitamin C originally contained in the milk.

In tomato juice, at its natural acidity of pH 4.2 to 4.3, only

50 percent of the vitamin C was found to be destroyed in heatin for one hour at 100° C.; but when the medium was brought to pH 9 before heating, the destruction was increased to 65 percent.

RELATION OF VITAMIN C TO NUTRITION

It has been observed when food is used which is adequate in other respects but deficient in vitamin C, scurvy develops. Even before definite signs of scurvy appear, there is often a pre-stage symptom of a change in general health. There may be constipation, a muddied skin, fretfulness, loss of energy, bloated abdomen, furred tongue, and a dry and scaly condition of the scalp. The infant will probably give a sharp cry when moved, which i frequently attributed to a pin prick. Close observation will show a slightly yellowish tinge on the skin of the legs, joints, and thighs. These and further disturbances may usually be treated o avoided by an adequate amount of orange or tomato juice.[3]

VITAMIN C IN FOOD MATERIALS

Both orange and tomato juice are among the richest source of vitamin C. If properly sprouted, grains and legumes have als pronounced antiscorbutic properties. Apparently in the sprouting of the seed there occurs a marked development of vitamin C. Vitamin C formed in the sprouting seed passes as a constituent of the juice or sap into the growing parts of the plant; therefor it is present most abundantly in the fresh green leaves, the growing shoots, and the juicy stems, roots, tubers, bulbs, and fruits In addition to oranges and tomatoes, vitamin C is found mos abundantly in lemons, grapefruit, and raw cabbage. Apples, bananas, carrots, and potatoes do not contain such a high percentage of the vitamin but are important as antiscorbutics because of the large quantities eaten.[3]

VITAMIN D

Vitamin D is definitely the antirachitic vitamin. Studies o the different derivatives of cholesterol and calciferol have show the existence of at least six forms of vitamin D other than th two forms known to occur in nature in fish liver oils. The potenc of these different forms differs greatly.[59]

Scurvy and rickets are two members of the unbalanced metabo lism family and can be prevented by direct sunlight or artifici irradiation, an abundant supply of minerals in the diet, and

supply of vitamin D, as well as of vitamin C. These factors are closely correlated. The irradiation seems to act primarily by producing the vitamin in the body, and the vitamin seems to act primarily by mobilizing the calcium and phosphate supply brought to the bone by the blood serum, so that a normal deposition of calcium phosphate takes place.

According to Park's definition, rickets is a condition in which the mineral metabolism is disturbed in such a way that calcification of the growing bones does not occur normally. When the calcium content of the serum is normal but its phosphorus content is subnormal, there results the so-called low-phosphorus form of the disease. On the other hand, when the phosphorus content of the serum is normal but its calcium content is subnormal, there results a low-calcium type of rickets which is often accompanied by tetany. When both calcium and phosphorus are reduced below normal in the blood serum, calcification is retarded, but the structural abnormality of the bone differs from that of the other two types. In our experience, this last form is the one most frequently encountered. Briefly then, rickets in children may be induced or prevented by changes in the amounts and properties of calcium and phosphorus, as well as by other salts and nutrients in the food. Of even more importance is the amount of vitamin D. We are of the opinion that through heredity some infants have a greater power than others to thoroughly metabolize the amounts of calcium and phosphorus ingested with the foods which contain them.[3]

TRANSFERENCE OF VITAMIN D TO THE INFANT

If the dietary of the pregnant mother is properly balanced she tends to store certain amounts of vitamin D in her body, which is passed on to the fetus. A lack or loss of calcium and phosphorus in the mother's diet affects, to a great extent, the antirachitic potency of her milk. In some parts of the world it is still the custom for a mother to suckle more than one baby, her own and a stranger. This is very apt to lead to her malnutrition, to a decline in the calcium and phosphorus content of her milk, and eventually to the underdevelopment of both children nursed.[3]

VITAMIN E

A brief discussion of vitamin E is within the scope of these pages, since it forms one of a series already enumerated. Also it

bears a close relation to a proper metabolism in connection with the nursing of infants. Not only is vitamin E necessary for reproduction, but for the nursing of the infant as well. It is believed that the lack of vitamin E causes a failure in placental function typically leading to resorption of the fetus.[3]

Vitamin E is fat-soluble and is believed to contain a factor which prevents sterility. It might be termed a ghost vitamin for at present its chemical constitution and derivation are apparently undetermined. This vitamin is associated with the lipoid constituents of the diet which appear to be necessary for normal spermatogenesis in the male and for normal gestation in the female. A deficiency of vitamin E in the male results in degenerative changes in the testes, with consequent sterility. In the female sterility is often due to a lack of a stimulation of the pituitary through vitamin E.

Vitamin E is believed to occur in a wide variety of foods of both plant and animal origin. It is found in vegetables, meat, milk, and butter, while wheat germ oil is an exceedingly rich source of it. Apparently it is not easily destroyed by heat, but the oxidation of the fats with which it is associated appears to produce an antagonistic substance. It is likewise destroyed by iron salts, possibly through their influence on the oxidation of fats.

FOOD SOURCES OF VITAMINS A, B, C, AND G

In the main, the letters designating the various vitamins have little meaning for the layman. He is interested only in knowing which foods contain them. Therefore we are submitting a table of foods with their vitaminic values as prepared by Sherman.

Information:—

† indicates that the food contains the vitamin
†† indicates that the food is a good source of the vitamin
††† indicates that the food is an excellent source of the vitamin
– indicates that the food contains no appreciable amount of the vitamin
? indicates doubt as to presence or relative amount
* indicates that evidence is lacking or appears insufficient

Food	Vitamin A	Vitamin B	Vitamin C	Vitamin G
Almonds	†	††	†	*
Apples, raw	†	† to ††	††	††
Asparagus	variable	††† ?	*	††† ?
Bacon	– to †	† to ††	?	††
Bananas	† to ††	† to ††	††	††
Barley, whole	†	††	–	†

Food	Vitamin A	Vitamin B	Vitamin C	Vitamin G
Beans, kidney	†	††	*	*
Beans, navy, dry, or canned	†	††	*	*
Beans, sprouted	†	††	††	*
Beans, string	††	††	††	*
Beef	†	††	– to †	††
Beef juice	*	†	– to †	*
Beef fat	††	–	–	–
Beets (roots)	†	†	†	††
Beets, leaves	††	††	*	†††
Beets, stems	*	†	*	††
Brazil nuts	†	††	*	*
Bread, white, water	?	†	–	?
Bread, white, milk	†	†	– to †	†
Bread, whole wheat, water	†	††	?	†
Bread, whole wheat, milk	††	††	– to †	††
Butter	†††	–	–	–
Buttermilk	†	††	† variable	†††
Butternuts	†	††	*	*
Cabbage, green, raw	††	††	†††	††
Cabbage, head, raw	†	††	†††	††
Cabbage, head, cooked	†	††	†	††
Cabbage, head, canned	†	††	†	*
Cantaloupe	††	††	††	*
Carrots, fresh, young	†††	††	††	††
Carrots, old, raw	†††	††	†	††
Cauliflower	†	††	†	††
Celery, bleached stems	– to †	††	*	*
Celery, bleached leaves	†	††	*	*
Celery, green leaves	††	††	*	*
Chard	††	† to ††	*	*
Cheese, whole milk	†† to †††	*	*	*
Cheese, cottage (skim)	†	*	*	*
Chestnuts	*	†	*	†
Cocoanut	†	††	*	††
Cocoanut oil	– to †	–	–	–
Cod liver oil	†††	–	–	–
Corn (maize), white	†	††	–	†
Corn (maize), yellow	††	††	–	†
Corn meal	– to †	*	–	*
Corn oil	†	–	–	–
Cotton seed (flour or meal)	†	††	*	††
Cranberry (or juice)	*	*	†	*
Cream	†††	††	† variable	†††
Cress, water	†††	††	†††	††
Cucumber	– to †	†	†† ?	*
Dandelion greens	††	††	†	††
Egg white	–	–	– ?	††
Egg yolk	†††	††	– ?	†††
Eggs	†††	† to ††	– ?	†††
Eggplant	†	†	*	*
Endive	†	*	†	*
Escarole	†††	*	*	*

Food	Vitamin A	Vitamin B	Vitamin C	Vitamin G
Filberts	*	††	*	††
Fish, fat	†	†	*	*
Fish, lean	– to †	†	*	*
Flour, white	–	– to †	–	– to †
Flour, whole wheat	†	††	–	†
Grains, whole, dry	†	††	–	†
Grains, sprouted	†	††	††	*
Grapefruit (or juice)	†	††	†††	††
Grapes	†	† to ††	†	*
Grapes, juice	†	† to ††	† ?	*
Ham	– to †	††	–	††
Hickory nuts	*	††	*	*
Honey	–	–	–	–
Ice cream (genuine)	††	††	† ?	†††
Kale	††	*	*	*
Kidney	††	††	† ?	†††
Legumes, sprouted	*	†† ?	††	*
Lemon juice	†	††	†††	††
Lemon juice, dried	?	††	†††	††
Lettuce	† to ††	††	†††	††
Limes (or juice)	–	*	††	*
Liver	†† to †††	††	†	†††
Margarine	– to ††	–	–	–
Milk, whole	†††	††	† variable	†††
Milk, scalded	†††	††	† variable	†††
Milk, condensed	†††	††	† variable	†††
Milk, evaporated	†††	††	– ?	†††
Milk, dried, whole	†††	††	Variable	†††
Milk, dried, skim	†	††	† variable	†††
Milk, fresh, skim	†	††	† variable	†††
Molasses	–	†	–	*
Mutton	– to †	††	*	*
Mutton fat	†	–	–	*
Oatmeal	– to †	††	–	†
Okra	*	††	*	*
Oleo oil	†	–	–	–
Olive oil	– to †	–	–	–
Onions, raw	– to †	†	††	†
Onions, cooked	– to †	†	†	†
Orange (or juice)	††	††	†††	††
Orange peel	†	†	††	*
Oysters	††	††	†	††
Palm oil	†	–	–	–
Parsley	*	††	*	*
Parsnips	– to †	††	*	*
Peaches, raw	† to ††	† to ††	††	*
Peanuts	†	††	*	*
Peanut butter	†	††	*	*
Pears	*	††	†	††
Peas, young, green	††	††	†††	†
Peas, dry	†	††	?	†
Pecans	†	††	*	*

Food	Vitamin A	Vitamin B	Vitamin C	Vitamin G
Peppers, green	††	††	†††	*
Pine nuts	†	†	*	*
Pineapple, fresh, raw	††	††	††	*
Pineapple, canned	††	††	†† ?	*
Pork	– to †	††	–	††
Potatoes, sweet	††	††	††	*
Potatoes, white	†	††	††	††
Prunes	††	††	–	*
Pumpkin	††	†	†	*
Radish	– to †	††	††	*
Raisins	–	†	–	*
Raspberries	*	*	††	*
Rhubarb	*	*	†	*
Rice, polished, white	–	–	–	–
Rice, whole grain	†	††	–	†
Roe, fish	††	††	?	*
Romaine	††	††	*	*
Rye, whole	†	††	–	†
Salmon, canned	†	*	*	††
Sauerkraut	†	†	† to ††	*
Shrimp	†	*	*	*
Spinach, raw	†††	††	†††	††
Squash, Hubbard	††	*	*	*
Starch	–	–	–	–
Strawberries	†	†	†††	*
Sugar	–	–	–	–
Sweetbreads	†	†	*	*
Tomatoes, raw, canned	††	††	†††	††
Turnips, white	– to †	††	††	††
Veal	– to †	† ?	*	††
Walnuts	†	††	*	*
Wheat bran	†	†† ?	–	†
Wheat flour, white	–	† ?	–	†
Wheat, whole	†	††	–	†
Yeast	–	†††	–	†††

VITAMINS AND HORMONES

Later knowledge in the study of nutrition tends to show that many functions of the body are undoubtedly influenced by the cooperation of the vitamins with the hormones. A balanced metabolism in infants and children, among other factors, must be a harmony between these two substances. While the first hormone and the first vitamins were specifically discovered and christened in 1903 and 1911 respectively, many claim that the vitamins actually date to Eijkmann in 1897. However, their discovery may even reach back 180 years ago to the first reliable description of

A VITAMIN PRIMER[62]

(All the vitamins are necessary to growth, fertility, and long life)

Vitamin	What It Does for You	What Happens if You Don't Have Enough	Where You Find It in Large Amounts
A	Keeps certain eye tissues and all mucous surfaces healthy	Eyesight is impaired. Resistance to certain infections decreases. Skin dries and thickens. Tooth enamel is weakened	In green and yellow vegetables, dairy products, fish liver oils, eggs, liver
B	Keeps nerves healthy. Promotes appetite and digestion	Beriberi develops. Appetite fails. Stomach and intestines grow sluggish.	In yeast, whole-grain cereals, nuts, beans, peas, many vegetables, and fruits
C	Keeps blood vessels, teeth, gums, and bones healthy	Small surface blood vessels rupture. Teeth loosen, fall out, or die	In oranges and other citrus fruits, tomatoes, green peppers, most fruits and vegetables if eaten fresh, quickly cooked, or commercially canned
D	Builds and preserves strong bones and teeth. Normalizes blood	Rickets develop in children. Teeth are poorly formed and decay. Heart action is affected.	In fish liver oils, viosterol, egg yolk, salmon, sardines, herring, irradiated (or vitamin D fortified) milk and cereals, sunlight
E	Is necessary for fertility in certain animals and probably in man	Young in embryo cease to develop; may be absorbed by mother's body	In green leaves, whole-grain cereals. Eggs, vegetable oils, muscle meats
G	With other substances protects against pellagra	Pellagra develops	In yeast, eggs, milk, lean meats, most fruits, and vegetables

scurvy by Lind, or to Magendie 100 years ago. Funk gave the vitamin its first explicit name. Berthold in 1849 showed the existence of hormones, but Bayliss and Starling in 1904 gave the first clear cut demonstration of them in its modern sense.

It is hard for the student of nutrition to keep up with the advance in vitamin discoveries, many of which are demonstrable in animals but not as yet in human beings. One such fat soluble vitamin may be described as K, and promotes the coagulation of the blood in birds. Closely related to it is another factor known

as the gizzard-erosion factor (Almquist and Stokstad), a separate vitamin but without a letter, the lack of which chemically results in the erosion of the lining of the gizzard of birds, producing an ulcer-like area on the surface. There is also a water soluble vitamin designated by the letter P (Szent-Györgyi), which is closely associated with vitamin C and is present in lemon juice and Hungarian pepper, together with ascorbic acid.

It cures purpura hemorrhagica but does not influence the ordinary thrombopoenic forms of capillary hemorrhage found in scurvy. Vitamin K is a flavone glucoside from lemon juice and is called citrin. Possibly the name ribroflavin may in time replace the name vitamin G. Nicotinic acid tends to replete a dietary deficiency in human pellagra. New advance has been made in the study of vitamin B2 complex, one of whose factors is responsible for a certain form of dermatitis in the rat. Another factor is found as a filtrate from the alcohol-ether precipitation of liver, and prevents the hair of black rats from becoming gray.

In recent years several hormones have made their appearance also, and there has been a clearer recognition of the many varieties produced by the anterior pituitary gland. Rowntree and associates have demonstrated a hormone produced by the thymus gland which affects the general growth rate, especially the rate of development in the line of differentiation. The pineal gland, while it stimulates differentiation, retards growth. There are also a large number of new hormones produced by the intestinal mucosa. In general, it may be said that the effect of a well characterized hormone or vitamin is the same, or at least its action is in the same direction in different species. Exceptions are found, however; for the rat can produce its own vitamin C and man his own vitamin B3. The chemical relationship between these two products gives evidence that some substances may be called vitamins, some hormones; such for example is vitamin D. Eleidin is activated by ultra-violet radiation on the human skin to produce vitamin D, which is secreted by the sebaceous glands. This substance belongs to the sterols and is similar to ergosterol. Indeed eleidin might be called a hormone, but as it cannot influence the body before being activated it may take on the nature of a vitamin. Possibly then, vitamins may be regarded as exogenous hormones and hormones as endogenous vitamins.

VITAMIN A AND THYROXIN

Research has noted a relationship between vitamin A and thyroxin, a product of the thyroid gland. Anelin, in 1930, showed that experimental thyreosis could be benefited with a vitamin A rich diet. Vitamin A, he pointed out, has a direct effect on the incretion of thyroxin. Fasold and Peters found that hypervitaminosis from an over-administration of vitamins, and characterized by cachexia, skin changes, bleeding diarrhoea, and fragility of bones, could be speedily cured or prevented entirely by thyroid feeding. Fellinger and Hochstadt proved that vitamin A in guinea pigs protects the thyroid against the stimulating effect of the thyrotropic hormone, which is produced by the anterior pituitary gland and which acts on the thyroid to keep it in functional condition.

THIAMIN (B1) AND HORMONES

Sure and Smith, experimenting with rats, discovered that large amounts of thyroxin counteracted the good effects of vitamin B1, the vitamin which affects the appetite and thereby increases food intake, and serves to offset the increased catabolism caused by thyroxin.

Vitamin B1 shows an interrelationship with the testes and adrenal gland. The secretion of the male hormone is reduced by a B1-deficient ration. In certain animals hypertrophy of the adrenal follows violent exercise.

ASCORBIC ACID AND HORMONES

Vitamin C, generally available as crystalline ascorbic acid, is related to the hormones in many ways. It is present in larger quantity in the hypophysis, in the corpus luteum, but is found less in the adrenal gland, thymus, spleen, testes, pancreas, and thyroid. Schneider and Widmann concluded that the intravenous administration of 50 to 100 mg. of ascorbic acid in man decreases the serum globulin but increases the serum albumin, and that it causes a decrease in the blood sedimentation rate, the blood being more viscous. Ochme reported that 20-25 mg. of ascorbic acid administered daily decreases hypermetabolism caused by 100 gamma of thyroxin. Liver glycogen in the guinea pig, for example (Hirsch), has been raised as much as 60 percent by the injection of 25 mg. of ascorbic acid intraperitoneally over a period

of 24 days. Thyroxin causes a reduction of liver glycogen, which is prevented by the use of ascorbic acid. However, it cannot be said that because a vitamin affects certain phases of thyroxin action physiologically it will in consequence affect all others. Vitamin D is undoubtedly related to calcium metabolism, in its physiological action, with the function of the parathyroid gland. It raises the calcium level in the blood and in the excreta and also increases calcium absorption from the alimentary canal.

VITAMIN E AND HORMONES

Sufficient evidence exists which shows that vitamin E influences the gonads, for it promotes the development of the fetus and the normal relationship between the mother and the fetus. Indeed, it is probably more specific in its action in the body than are the general growth hormones, A, B, C, and G.

GENERAL CONSIDERATIONS

The whole subject of vitamins and hormones is so attractive that it tends to tempt incompetent workers, drug manufacturers, and food products producers to emphasize them beyond the bounds which nature intended. Various vitamin concentrates and crystalline hormones are now being investigated by pharmacologists. The dietitian, the physiologist, and the biochemist work together, for the dietitian enumerates the foods containing vitamins and the latter show how to differentiate and prepare them. Spurred by blatant, artistic, and alluring advertisements, people flock to physicians and drug stores for vitamin concentrates and hormone preparations to restore imaginary food deficiencies and lost man- and womanhood. Already an overadministration has caused diseased conditions in a mild form. Unless restricted, it may be prophesied that the abuse of these two substances will in the future produce a new array of diseases.

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CHAPTER 13

FRUITS

A RICHLY laden orchard, its fruits sunkissed and displaying on their surfaces many of the pure colors of the rainbow and many of the blends found on the color scale, is no idle picture of the imagination. The fragrance of the fruit permeates the atmosphere and its full-ripened lusciousness captivates the appetite. The use of fruits as a food is no new adventure. Savage tribes both in the past and present, particularly in the tropics and semi-tropics, subsist to a large extent on fruit and nuts, with meat or fish at rare intervals. Such a diet proves very nutritious. Some authorities boldly credit a fruit and nut regimen with having a higher nutritive value than meat or its products. However, no one article of food and no particular foods can entirely balance metabolism. Each food is but a part of a generalized whole, and it is only when the metabolism is balanced that physical and mental health can be maintained. Both savages and civilized men often lack something in their diet to make their organized life complete. An inadequate diet for infants and children is never satisfactory for growth and health. Major McCay, as quoted by Brice, tells of his experiences with the natives of the plains and with the Hill tribes of lower Bengal. He found that the fruit eating and pure vegetarianism as practiced by the Bengalese and Beharis Indian tribes were unsuitable and detrimental to health, that such habits tended to degrade and to inhibit mental and physical progress, as well as to cause such an increased peristalsis of the bowel that ingested foods were literally thrown out long before they were properly digested. Even when the body organs were functionally normal, the excessive amount and bulk of the food in the alimentary canal prevented its adequate absorption. In his studies on the Bengalese, McCay discovered that not more than fifty-five percent of the protein of their food was metabolized. Flesh foods are commonly regarded as necessary to physical and mental vigor and well-being, but, says Sager, they are often inferior in nutritive worth to many plant foods and to fruit. Fructarians who profess to live on fruits and nuts point to the fact that, while meat and its products putrefy quickly in the intestine, fruits and nuts decay but slowly. They firmly be-

lieve, therefore, that the latter products are more fitted for an ideal diet.

Moses said, "Out of the ground made the Lord God to grow every tree that is pleasant to the sight and good for food." And elsewhere in the Bible we read, "When the woman saw the tree was good for food, and that it was pleasant to the eyes and a tree to be desired to make one wise, she took of the fruit thereof and did eat and gave also unto her husband with her and he did eat." No other food in its natural state is so calculated to afford pleasure to three out of the five senses of the child as does fruit. All the beauty and richness of pure and blended colors both attract and hold the eye. Its ripeness, sweetness, and lusciousness tempt the palate, and its fragrance, so often simulating that of flowers, charms the nerves of smell and aids in stimulating jaded appetites reflexly. The addition of raw as well as cooked fruits and their juices to the child's diet tends, other things being equal, to keep the child in perfect health, with buoyancy of spirits, good humor, and happiness with the world at large. According to Tibbles, these results are due at least partly to the contained vitamins and inorganic salts, which arouse the appetite and aid digestion by increasing the flow of saliva and, indirectly, that of the gastric and intestinal juices. Fruits are stimulants and, at the same time, sialogogues. As the fruit reaches the intestine, its acids increase the activity of the chyme, stimulate the secretions of the liver, the pancreas, and the intestinal glands, as well as the muscles. Fruits and their juices render the blood less alkaline, but never acid. Combining with a portion of the alkaline salts of the blood serum, the phosphoric acid of the fruit increases the phosphates in the red blood cells. In nutritional anemia, in scurvy, in general muscular weakness, and in many forms of minor inherited dysfunctions, as well as during recovery from an acute illness, fruit juices have proved of inestimable value. It is supposed also that fruits contain a minimum amount of that earthy material which certain authorities contend is the chief cause of certain types of obstruction in the intestines. According to Carrington, fruits are causative factors in the ossification of the bones and in the prevention of premature old age. No drug, laxative, or cathartic can compare with fruit and its juices in cleansing the intestinal tract of the products of fermentation and decomposition.

Dr. Victor Panchet of Paris, when asked what were the best food for a patient in preparation for an operation, replied, "It is necessary to give foods which, besides being devoid of toxins should be bad culture media for the germs inhabiting the intes-

tines." Indeed, in intestinal intoxications with constipation, a fruit regimen fulfills such a contingency. The juices of fruits contain a fluid purer than water obtained from any spring. One sometimes feels that many a mother gives her child fruit to please him rather than for its food value, and, indeed, some misguided misanthropes have pronounced fruits as completely devoid of nutritional worth. Sylvester Graham speaking on this point remarks, "It should be remembered that fruit of every description, if eaten at all, should be eaten as food and not merely as a pastime or for purely gustatory enjoyment." We recommend, therefore, that when possible fruit be eaten at table, and that it constitute a portion of the regular meal. Lorand states that some fruits are richer in iron and in lime than many ordinary foods which are popularly believed to contain these elements in abundance.

Note the attitude of a child toward fruit placed in front of him. First he is attracted to it, then he handles it, and lastly smells it. The fine aroma which he so much enjoys springs from the etheral oils which are contained in the skins of the well-ripened product. The aroma or the sight of the fruit may not correspond to the delight of tasting it, or vice versa. Often its sweetness or deliciousness may not be determined by outward appearances alone. Truelle, after many years of observation, found that fruits with yellow skins contain much sugar but possess little perfume. As a general thing, fruits with glossy skins are juicy and have a strong aroma. In the fully ripened fruits the quantity of acid and of cellulose is lessened. To obtain, therefore, really sweet fruit without much acid, many varieties should be allowed to hang on the tree until ripe. "As fruit ripens," Thompson says, "it absorbs more and more oxygen, and the tannins and vegetable acids which it originally contained are so altered that it becomes less astringent and acid, the starch is more or less changed into levulose or glucose, and a soluble pectin is formed." The aroma and taste, Truelle affirms, depend on the relative quantity of these different substances, together with certain volatile ethers and oils in the skins. In prescribing fruits for infants and for healthy or for ill children, it is well to remember that the more luscious the fruit the more soluble are its sugars and the special flavoring substances which it contains. Pectin, incidentally, is a soluble carbohydrate substance found in ripe pulpy fruit. It enables the fruit to gelatinize when boiled with sugar. Pectose and pectase are similar substances but are found in unripe fruits. The albuminous products of raw fruits are easily assimilated in the digestive tract. Hutchinson

states that "eighty percent of fruit protein, ninety percent of fruit fat, and ninety-five percent of fruit carbohydrates are absorbed."

In regard to the administration of fruit in excess, precautions suggested are practically no different from those enjoyed in giving any other food in overdoses when it is occasionally liable to cause mild digestive disturbances. The keen clinician may possibly ask himself several pertinent questions as to the choice of fruits for a given patient. Is the fruit prescribed appetizing and palatable? Will it refresh? Has it high nutritional properties? Is the fruit fully ripe or partly green? Does it contain a large amount and variety of mineral salts? Does it contain certain vitamins? What is its diuretic and laxative action; for each fruit has dissimilar potentialities? What is its stimulating and tonic action? He may have to make a choice between raw or cooked fruit and may have to decide when each variety is indicated. The raw juices of certain fruits seem to have a particular property, a special vitality or tang, possibly electrical, over those of other fruits. The carbohydrate content of fruit is glucose, levulose, and saccharose, although the latter is present in very small amounts and tends to diminish in proportion to the ripeness. This levulose or fruit sugar represents starch in a state of complete digestion and ready for instant absorption. In obscure cases it may cause the formation of acetone, although this has not occurred in our experience. The final stage in the digestion of fruit is the conversion of the fruit acids and mineral salts into alkaline salts, chiefly the carbonates. These pertinent facts have been wholly disregarded by many who have forbidden raw ripe fruits to their patients suffering from rheumatism and other acid forming conditions. Owing to these alkanizing properties many fruits neutralize the acidifying effects of meat and egg excess in the diet, and control to a great extent the sequelae of a rheumatic or gouty diathesis. It is possible to visualize a deficiency of certain inorganic fruit acids in specific body cells, which not only need them themselves, but might want to proportionate them to other cells so that the metabolic machinery may be suitably adjusted for the good of the organism.[1]

Nature, in her readiness to help mankind, has given to every individual fruit its own specific nutrient acid. Malic acid, for example, is contained in apples, pears, currants, berries, pineapples, grapes, and cherries. Citric acid is present in the juice of lemons, limes, oranges, currants, unripe tomatoes, and in the gooseberry, a fruit unfortunately undeveloped in this country. Tartaric acid is characteristic of grapes, and racemic acid, a

variety of tartaric acid, is found in small quantities in some fruits, notably in the grape. These fruit acids commonly occur as the acid salts of potassium, sodium, and calcium, and give to the fruit its agreeable flavor. One may have noted the high percent of sugar and the richness of the acid contained in the tamarind, a variety of fruit seldom seen in northern hemispheres.

J. Koenig gives the following composition of certain fruits and berries, based on a series of analyses:—

Berries[1]	Water Percent	Nitrogen Percent	Sugar Percent	Other Carbo-hydrates Percent	Cellulose Percent	Carbon Percent
Gooseberries........	85.74	0.78	7.03	1.91	3.52	1.15
Strawberries........	87.66	0.57	6.28	6.48	2.32	0.93
Currants............	84.79	0.51	6.18	0.90	4.57	1.15
Raspberries.........	82.60	1.60	7.14	3.04	3.91	

Fruits[1]	Water Percent	Nitro-gen Percent	Salts Percent	Sugar Percent	Other Carbo-hydrates Percent	Carbon Percent	Cellu-lose Percent
Prunes............	81.18	0.78		6.15	4.92	0.58	5.41
Apricots..........	87.70	0.93	0.12	8.10	1.60	0.64	1.41
Pineapple, in can....	75.70	0.60	0.06	18.40	4.35	0.24	0.57
Bananas, peeled.....	73.40	1.44	0.09	21.90	2.03	0.92	1.22
Figs, fresh..........	84.80	0.79	0.22	8.30	3.85	0.71	1.23
Medlar pears (acid)..	92.60	0.61	0.07	2.90	1.40	0.69	0.23
Peaches...........	86.60	0.48	0.48	6.70	3.63	0.51	1.19
Pears..............	88.50	0.04	0.04	6.40	3.73	0.17	1.12
Apples............	82.60	0.06	0.06	8.90	5.51	0.28	1.21
Cherries..........	79.82	0.67		10.24	1.76	0.91	6.07

GENERAL FUNCTIONS OF THE MINERAL ELEMENTS

Fruits are great storehouses of mineral salts, and they occupy a commanding position in child nutrition. Their general functions may be enumerated as follows:—first, the mineral salts are constituents of the bones and teeth and they give rigidity and relative prominence to the skeletal tissues. Second, they act as the essential elements of the organic compounds which are the chief solid constituents of the soft tissues (muscles, blood cells, etc.). Third, as soluble salts (electrocytes) held in solution in

the fluids of the body, they give these fluids their characteristic influence on the electricity and irritability of muscle and nerve. These salts also supply the material for the acidity or alkalinity of the digestive juices and other secretions, but at the same time they maintain the approximate neutrality of the body fluids, as well as their osmotic pressure and solvent power. The healthy active child on the average ration probably excretes in the neighborhood of twenty to thirty grams of mineral salts daily, and these consist mainly of the chlorides, sulphates, and phosphates of sodium, potassium, magnesium, and calcium, and also of small amounts of the ammonium salts derived from protein metabolism. All these obviously must be replenished by a proper diet. For the growth, development, and health maintenance of the child, there must be a sufficient intake of mineral constituents to cover the output, and in addition there must be a still larger amount to provide for a daily storage. As children vary greatly in their mineral salt output and in their organic demands for an adequate intake, it can be readily appreciated that no standards can be set and that individual needs can be computed only by clinical observation.[2]

FRUIT SUGARS

The sugars in fruits, while present in a most appetizing form, are also a biologic means by which the child may obtain in sickness and in health a perfectly digestible, assimilable, and metabolizable saccharine in a natural state. In the fruits one may discover a great variety of sugars which are suitable for infant and child metabolism; cane, grape, and fruit sugars being contained in them. Fruits are the best natural sources of dextrose and levulose. The stage of growth and the degree of ripeness of the fruit have a very decided effect on the kinds and amount of sugar found in it, and it is very difficult to give even average figures which will fairly represent the quantity of sugar present. Invert sugar, for instance, ranges approximately from about two percent in large early apricots to possibly fifteen percent in grapes, and in a certain variety of sweet cherries; while strawberries, gooseberries, raspberries, and apples contain about one half of this percentage. Incidentally, homemade jams and jellies may contain a very large proportion of this invert sugar. Cane sugar in fruits ranges from less than one half percent in lemons to fourteen percent in a certain variety of plums. Ripe bananas possess a high percentage of cane sugar, approximately eleven percent.[3] The pineapple, one of the most beneficial of al

ruits. has a percentage of about 11.33 of cane sugar. It is well o warn parents when their children are suffering from hyper-acidity not to give the acid fruits and their juices in excess. While it is perfectly true that the fruit juices are later transformed in the system into alkalis at first, they are thrown into he stomach as organic acids and tend to further acidify the gastric contents. It has seemed to us that the addition of a raw acid ruit at breakfast has, to a certain extent, decreased the child's subsequent desire for sweets and candies.[4]

THE ANTI-SCORBUTIC PROPERTY OF FRUITS

Stories of Arctic exploration, of hardships endured, of privations suffered, tales of death from scurvy and the rescue of men rom this disease through the timely arrival of lemon juice, made a deep impression on the hero worshipers of a former generation. It has been known for a very long time that fresh vegetables and fruits will either prevent or cure scurvy. We submit the following advice from Plaundler and Schlossmann in the nutrition of children as voicing, to some extent, our own views. "In place of the food," they say, "which has heretofore been given, he child should receive fresh, at most briefly heated, or still better, raw cow's milk, provided that this may be obtained from a reliable source. Besides the milk, two to four teaspoonfuls of raw meat juice per day should be prescribed and also the same amount of fresh fruit juice obtained from oranges, grapes, lemons, cherries, currants, blackberries, apples, pears, apricots, huckleberries, etc., in, and not out of, season, and all sweetened with sugar. To children in the second or third year of life, in addition to the fresh milk and fresh fruits, there should be given potato, vegetable soup, carrots, raw cabbage, cauliflower, onions, spinach, stewed fruits, green salads, not only for their vitamins and salts, but for their anti-scorbutic qualities."

In the treatment of scurvy, malnutrition, and certain types of nutritional eczemas allied to them, experience has taught that it is unwise to give general directions in advising fruits and vegetables, but to be more specific, especially in aggravated cases, in order that the anti-scorbutic content of the food chosen, whether high or low, may correspond in some degree to the type of ailment under consideration. Until one knows the approximate quantitative anti-scorbutic content of each green stuff, such as the fruits and vegetables, he cannot consider them individually or collectively interchangeable in the treatment of scurvy. Particularly is this true in times of drought and eco-

nomic depression. This point may be better appreciated by ar illustration. Some years ago, soon after the World War, a Britisl mission was sent to Vienna, Austria, to study the deficienc diseases in the children of that city. "Some children in ou charge," the members of the mission reported, "were gettin fifty grams of raw apple juice daily as an antiscorbutic and mucl to our surprise began to show symptoms of a kind which we hac learned to associate with the first onset of scurvy. We had, how ever, no experimental data as to the antiscorbutic value of rav apple juice; we only knew that it was much inferior to the juic of the lemon and of many other fruits. Accordingly, we sub stituted ten grams daily of raw neutralized lemon juice, anc with excellent results." At the present time the antiscorbuti qualities of cabbage, onion, tomato, potato, and of the orang are fairly well known, and a famous Arctic explorer has pointec out the same characteristics of raw meat.

That the cheap and humble banana, and, to a lesser extent the universally liked apple share antiscorbutic potencies is les well known. Whether in London, Berlin, Constantinople, or ir New York; whether in East Africa, the Congo, or in the Soutl Sea Islands; whether under the Arctic night, in a fisherman' humble cottage, or in the home of the farmer or industrialist there one may find the banana at all seasons of the year. Alsc in every home in New York, in New England, in the Middl West, as well as in London and parts of the British Isles, ther are but few homes without the apple. The apple is often referrec to as the king of fruits, and it is one of the most valued fruit in the child's diet, both in health and disease.

Osborne and Mendel have given proof that this fruit con tains the water-soluble vitamin B. Chick and her co-worker state that both fresh and dried apples have slight antiscorbuti potencies, while Carter, Howe, and Mason contend that driec apples, dried tomatoes, and strawberries, are all excellent anti scorbutics. Allowing that the raw apple and the raw banan possess antiscorbutic value, yet should these foods be subjectec to any considerable degree of temperature by desiccation, or b canning, the anti-scorbutic and vitamin potencies are in man cases markedly reduced.[5]

THE COMMON RAW FRUITS AND THEIR EFFECTS

THE APPLE

Carrington also calls the apple the king of fruits, for it is highly efficient food which can be served in a great variety c

vays—raw, baked, boiled, stewed, dried, or dehydrated, if prop-erly prepared, without losing many of its intrinsic properties. f served to the child in the raw state in the skin, it should first be washed thoroughly, for Sartori has demonstrated harmful bac-eria on the fruit even when washed twice. The apple is both a ood and an appetizer and it contains, according to Carrington, n abundance of potash, soda, magnesia, and phosphorus. Its atural acid is invaluable for the teeth and gums, for the stomach nd intestines, as it has an antiseptic and germicidal quality. urthermore, it probably decreases gastric hyperacidity and at he same time acts as a tonic to the mucous membrane. When iven on an empty stomach there results a natural, healthy move-nent of the bowels. With children, individual preference and n individual digestibility of the many varieties of this fruit may rouse attention.

Clinical experience tends to show that certain varieties of pples are better borne by the stomachs of some children than re others. A sweet, pulpy, ripe apple is most easily digested, s for instance, the snow apple, which fairly melts in the mouth. n the prerheumatic pains of growing children, the so-called rowing pains, the malic acid of the raw fruit seems to act almost s a specific. In the regions where apples are grown and plenti-ully eaten, and sweet cider made from them is drunk, renal alculi and uric acid concretions are seldom found.

Sour apples are not fit for children with weak stomachs. They ontain too much cellulose. A raw apple fit for a child to eat n the skin should be soft enough to be squeezed in the hand nder moderate pressure. Baked apples and apple sauce are mportant foods in infant and child nutrition. Apples which ipen in the summer usually contain less cellulose than do those vhich mature later, and are therefore better digested.[1] The fruit ot only contains the vitamins A, B, and C, but when young it ossesses a large amount of starch, which, as the apple ripens, s converted into sugar, a transformation similar to that found n the banana. As this transformation to sugar increases, so does he acid content decrease. Pectin, so valuable in the formation f jelly, likewise decreases during the ripening process.

THE BANANA, FIGS, PLUMS, PRUNES

THE CITRUS FRUITS

The citrus fruits are also excellent sources of nutrition. They ffer an excellent supply of readily assimilable glucose, and for

this reason orange juice is used when there is need of a quickl assimilable and metabolizable carbohydrate, which in its absorp tion will throw the least burden on the child's digestive systen Probably next in importance come lemons, grapefruit, limes, an tangerines. All these fruits are particularly rich in vitamin (while grapefruit contains both vitamin A and B; the others onl vitamin B and C.[6]

Grapefruit, in particular, is a valuable acid stimulant, pa ticularly at breakfast, for a child suffering from a hypogastri secretion, as it contains large quantities of citric acid, as well a other acids, while in comparison with many other fruits it con tains very little sugar. It is also a mild laxative. However, th prescribing of grapefruit juice for children in general is often precarious adventure. Older children suffering from long co tinued exhaustive conditions, where the secretions of the bod have been largely depleted and weakened, are greatly benefite by its acid, vitamins and salts. Children, too, with condition bordering on acidosis have, in our experience, been helped great deal by grapefruit, as it possesses a high potence of citri acid. Emotionally unstable children, those suffering from hype acidity, often cannot tolerate its acidity, particularly when, t mitigate the tart taste, sugar is added, for a subsequent fermen tation and diarrhoea may occur. The juice of the grapefruit con tains more acid than that of the orange, but less than that of th lemon. The Cuban variety, however, appears to be less aci and to be devoid of the extreme bitterness which to some exten characterizes the grapefruit of California localities and of other Of all the citrus fruits the orange is probably the most "foo proof," for orange juice can be prescribed in many condition Lorand gives the content of the orange as follows:—

Invert sugar	3.9	percent
Free citric and malic acids	1.93	"
Potassium citrate	1.39	"
Calcium citrate	0.25	"

However, even orange juice has its limitations, for it canno be given indiscriminately to infants in many instances withou dilution. This is because of a peculiar sensitization which possibly inherited. It may be due also to the fact that the qua ities of the orange ripened on the tree are different from thos of the fruit ripened during transportation. Another consider tion may be the character of the soil in which the orange grown.

GRAPES

Cujus Blinius, centuries ago, called attention to the value of rapes to the human organism. Grape juice stimulates the mu-ous membrane of the intestinal wall. It is an antiseptic, and lisinfects the intestines through the agency of the lactic acid which is formed. Injurious decomposition products resulting rom the unwise use of meat and eggs are rendered inert. In onditions of high tension of the blood vessels, therefore in rising lood pressures, grape juice has given excellent results, as it ends to diminish the viscity of the blood. In many skin affec-ions of childhood incident to malnutrition, the tartaric acid ontent of grape juice aids in their cure. In an inherited uric cid diathesis, in renal gravel and in kidney stones, in faulty di-estion, in intestinal fermentation and decomposition, in catar-hal jaundice and in liver stasis and congestion, in spleen and all bladder disturbances with the eventual formation of gall tones, as well as in many metabolic upsets, this juice has almost ordered on the miraculous in its effects. Grape juice is highly axative on account of its sugar and tartaric acid content, and is n addition a valuable diuretic. When adding grapes to the hild's diet, it is best to select those with thin, fine skins and mall seeds, but with abundant juice. With very small and with eakly children we suggest seeding the grapes, and obviously o skins must be eaten. We have no clinical knowledge as to he tendency of the child to take on fat following the prolonged se of grape juice. Niemeyer, however, believes that two or three ounds of grapes daily might make a person fat. He finds their ugar content to be from fourteen to eighteen or twenty percent, ut states that only a small amount of albumin is present. Granting this fat increase to be demonstrable, one may then ogically prescribe grape juice in phthisis and in other wasting iseases. Sweet grapes contain a high percentage of fluid in pure orm, seen as glucose or grape sugar, a type of saccharine which s easily assimilated by a weak stomach. Grapes and their juices ave been employed with great success in certain cases of gastric nd intestinal atony, in some types of bronchitis arising from alnutritional causes, and in uncommon forms of heart disease pringing from similar sources. Possibly Lorand's figures, which how the nutritive properties of grapes, are as accurate as any.

Protein	0.41	percent
Fat	0.56	"
Manganese oxide	0.24	"

Water	75.60	"
Other carbohydrates	2.	"
Cellulose less than	2.	"

He finds, incidentally, in one fourth kilo of grapes a caloric con-tent of seven hundred and fifty calories. Lorand gives thei nutritive content in further percentages as follows:[1]

Water	78.17	Percent
Albuminous products	0.59	"
Pectin bodies	1.96	"
Sugar	14.36	"
Free acids	0.79	"
Seeds	3.60	"
Ash	0.53	"

Incidentally, grape cure resorts are spread all over Europe.

THE EFFECT OF GRAPES AND OF THEIR PRODUCTS ON URINARY ACIDITY

Grapes are of great value in the child's diet, if only for the purpose of maintaing the alkaline reserve. Since many fruit acids are largely oxidized to carbon dioxide and water in the body, the ash constituents rather than the organic acids are the chief factors affecting the acid-base balance. It must be admitted however, that some fruits increase the acidity of the urine, even though the ash is alkaline. It would appear from research that a basic ash is characteristic of all varieties of grapes. Hartman and Tolman have found the alkalinity of the juice of the com mon grape, the Concord, to be relatively high. It has often been claimed that grape juice established an acid condition of the body and of the urine. Pickens and Hetler, however, found that no marked change occurred in the acidity of the urine even when large amounts of grape juice were ingested by their sub jects. It is very interesting to study the conclusions of Saywell and his co-workers, as contained in a summary of their sixteen experiments with male subjects on a basal diet and again on the same basal ration but supplemented by fresh grapes, fresh natural grape juice, detartrated grape juice, natural grape juice concentrate, and concentrate tartrate mixture. The following results were observed:—

1. An increase in the pH of the urine ranging from 0.8 to 1. pH units.

2. A decrease in the amount of ammonia excreted and a corresponding decrease in the total acidity.

3. An increase in the alkali reserve above the normal for each ubject, this reserve being estimated by the plasma carbon dioxde (CO_2) combining power which was determined from the cid and ammonia content of the urine and calculated by the nethod of Fitz and Van Slyke.

. A correlation between the alkalinity of the ash and the physioogical reaction. Grapes and grape products with the greater lkalinity of ash were associated with a more basic body reaction.

. An increase in the organic acids excreted. This may be exlained by the presence in the urine of some incompletely xidized tartaric acid.

. Approximately ninety-four percent of the ingested organic cids appeared to have been oxidized.[7]

One need not journey to Baden-Baden, to Badkreuznach, to witzerland, or to other grape cure resorts, to discover the worth nd metabolic value of unfermented grape juice. Today there s no question as to whether the afflicted child should undertake he grape cure at home or elsewhere, for modern processing nethods are able to preserve the raw juice for a long time. Our xperience seems to warrant the belief that many children have ertain likes and dislikes for various fruits and their juices; some referring grape juice, some apple juice, some pineapple juice, nd others the berry juices, while many enjoy a melange of everal fruit juices. In conditions of high or low fever, in subcute and acute rheumatism, in gastritis and stomatitis, particuarly where there is vomiting and retching, we have advised rape juice with marked success. Not only is there a quenching f the thirst, but the salts, vitamins, albumin, sugar, and fat ontents of the grapes aid in balancing metabolism, and their erfumes tend to restore the appetite reflexly. At times it is wise o thin the juice, not as so many advise with mineral waters, but vith plain, fresh drinking water. Particularly is this true when he child complains of an astringent, puckering sensation in he throat.[8] In two cases of cleft palate coming under our obervation, the juices of fruits were better tolerated than the ruit itself, since parts of the latter blocked the nasal passages. By stimulating the nerves of taste, grape juice, often in rich neasure, reacts upon the parotid gland, the stomach, and the ntestinal glands, aiding them in releasing their digestive fluids.[8]

FIGS

The Orient appreciates the nutritive properties of the fig much more than does the Occident. More attention should b given this food in the nutrition of children. Fresh figs contai from sixty to seventy percent of sugar, a large proportion o mineral salts, and an appreciable amount of manganese oxide probably about 0.21 percent. Orientals prize this fruit highl in diseases of the kidneys and bladder, and in gouty and rheu matic conditions. Smyrna figs are very digestible and are swee as honey. These figs contain 0.70 percent of phosphorus an 0.17 percent of phosphoric acid. Dried figs, the form usuall sold in northern markets, have too much cellulose to be easi digested, a content of 7.82 percent according to Balland, bu they can be well utilized in puddings, cakes, custards, etc. A summary of their composition by Balland is as follows:—

	Protein %	Fat %	Sugar %	Other Carbohydrates	Cellulose %	Ash %
Fresh figs.....	0.79	0.32	48.30	3.85	1.23	0.21
Dried figs.....	2.36	2.10	48.40	5.27	7.82	3.15

PLUMS, PRUNES, AND OTHER FRUITS

Plums are usually well digested, and are enjoyed by man children if not eaten too frequently. Prunes or dried plums ar a good laxative food, but are best given to very young childre in the form of juice or in prune whips and puddings, as thei skins are not readily digestible. It is usually best to remove th skins by soaking, when they may be prescribed for children wit weak gastric function. Cherries are another excellent food, a they contain 0.82 percent of manganese oxide, ten to twelv percent of fruit sugar, and the alkalinizing salts of potash, lime iron, and a larger amount of phosphoric acid than is containe in many other fruits. Apricots and peaches, when ripe, are usu ally well digested by children. Dates, another nutritious orienta food which is less in vogue than it should be, according to Ba land, show the following food content:—

Dates:—

Salts %	Phosphorus %	Protein %	Fat %	Sugar %	Other Carbohydrates %	Cellulose %
1.32	0.12	1.16	0.06	51.30	15.80	5.06

BERRIES

The so called "small fruits," the strawberries, raspberries, blackberries, gooseberries, cranberries, and currant, possess practically the same nutrients as do other fruits. Berries are easily digested by healthy childen but in some cases of gastro-intestinal dysfunction they may not be so well borne. Berries, even when ripe, often tend to irritate the intestinal tract. Strained fresh berry juices are frequently preferred to citrus fruits by many children. Children living in distant agricultural districts often cannot procure the other variety. Weiss, in Bunge's laboratory, found that strawberries were beneficial in gouty and rheumatic conditions, but that in hypersensitized children they may form with other foods a chemical irregularity which may lead to skin allergies such as urticaria, to other skin rashes, as well as to intestinal disorders. Raspberries, when ripe, are more easily digested than strawberries. They are especially rich in vitamin C. Currants and gooseberries are often very indigestible, as their seeds are large and coarse. Strawberries are reputed to contain a large amount of iron, and raw or preserved they have proved effective in secondary anemia. Blueberries and huckleberries possess a mild astringent action on mucous membranes and apparently are of some benefit in mild affections of the pharynx; they act also as a tonic on the intestinal tract and as a mild antiseptic on the intestinal contents. Precautions should be taken to wash the berries well before serving, as disease germs from filthy handling many lurk in the fruit, and these, in rare instances, may find their way into the blood streams.[1]

Berries with fine seeds are both constipating and irritating to the mucous membranes lining the digestive tract, but at the same time their organic acids aid digestion by increasing the flow of saliva and the digestive juices. Beside the irritating qualities of their seeds, blackberries contain enough tannin to be constipating. Berries, through their organic acids, tend to increase the activity of the liver and pancreas.[4]

THE BANANA

In the northern hemisphere the banana has had a hard upwar climb to its present high status as a food. The work of Walte W. Eddy and others has given it the importance it deserves.

The green color of the unripened banana is due to chlor ophyll. During the ripening process the yellow pigments, xan thophyll and carotin, change the color to greenish yellow, yellow with green top, full yellow, yellow with brown flecks, and finall the flecked, fully ripe fruit. Carotin is an excellent source of th pro-vitamin, A.

The hardness of the green banana arises from the cementin together of the cells by an insoluble substance known as pro topectin, which during the ripening process is changed int pectin and softens the texture of the fruit. This pectin is a valu able aid in nutrition.

The green fruit has an unpleasant odor. During ripening small amounts of ethyl amyl alcohol and acetic, formic, an valeric acids are formed. In the later stages of ripening, th acids and alcohols combine to form esters, notably the este amyl acetate and iso-amyl, a valerate, and perhaps also ethy acetate, which are responsible for the aroma of the fully ripene fruit.

The fully ripe pulp is nearly starch free and the fructose, o fruit sugar, is pure. It is at this stage that the fruit is mos readily digestible and therefore most easily metabolized.

The exact manner in which the starch is converted into suga has not been fully determined. Dr. John Nelson, of Columbi University, has traced the conversion of the starch to sucros and then to invert sugar. The process probably takes place i the following manner.

Starch, by means of the enzyme hexokinasel, becomes activ hexose (this may be glucose or fructose or a mixture of the two Active hexose combines with phosphoric acid present in th fruit under influence of an enzyme and becomes hexosemon phosphate. By the action of a respiration enzyme the two mol cules are broken down into:—

(A) Hexose—diphosphate
(B) Unknown sugar
(C) Carbon dioxide (CO_2)

Then hexose-diphosphate plus unknown sugar, plus oxyge plus glucose, by aerobic respiration enzyme, goes to sucrose, pl

ree phosphoric acid, plus carbon dioxide. An invertase may hen convert some of this sucrose into invert sugars, glucose, and ructose. This suggested conversion is partly theoretical. It ppears to indicate that the banana converts its starch into a torage sucrose, much as the muscle cell in an animal converts lucose into glycogen. Ripening of the banana, then, is a natuаl conversion of the originally starchy fruit into a soft textured, asily digestible sugar complex.[9]

The moderate astringency of the fruit is usually attributed to he presence of tannin. Jaehkel found that ripe bananas contain s much tannin as green. It is obvious, therefore, that bananas hould be served only when fully ripe, for they are then easily ligested in normal infancy and in later childhood, even by a oorly functioning digestive system. When the banana is fully ipe the skin is yellow, heavily flecked with brown, the pulp is irm but soft, and dissolves readily in the mouth without much nastication. Since the chilling of the fruit during transportation s likely to temporarily inhibit the activity of the enzyme which s essential to proper ripening, it is recommended that when ananas are all yellow or yellow with green tips, they be allowed o ripen at room temperature. If the fruit is fully ripened it nay be kept safely in the refrigerator until served either as a alad or a dessert. It may also be served cooked, as cooking inreases its digestibility.

In the case of very young children and children of weak digesion, this procedure is particularly advisable. While the yellow ipe banana may be easily digested by older children if properly masticated, it is obvious that the fully ripened fruit which asily melts on the tongue is to be preferred. It is less apt to emain as a compact mass in the digestive tract.

The following table shows the approximate analysis of the ully ripened banana:—

	PERCENT
Moisture	75.3
Ash	0.8
Fat	0.6
Protein	1.3
Crude fiber	0.6
Reducing sugars	7.1
Non-reducing sugars	11.1
Starch	5.2
Total carbohydrates other than fiber	21.4

The proportions of reducing sugar, non-reducing sugar, an starch vary considerably in many kinds of ripe bananas. I many cases the starch may disappear almost completely, whi the amount of reducing sugar increases, with a correspondin decrease in non-reducing sugar.

BANANA PROTEIN

With eighty-eight percent of its caloric value derived from th carbohydrates, it is evident that the amounts of protein and fa in fresh bananas are relatively negligible when seen as nutritiv contributions, but with the recent development of banan powder the proportion of protein becomes more significant. Th composition of the banana is given in the following table:—

APPROXIMATE NUTRIENT COMPOSITION OF BANANA PULP PRODUCTS AVAILABLE TO THE CONSUMER

Component	Average Fully Ripe Yellow Banana	Yellow Banana Powder	Ripe Red Banana
Water	77.4	2.5	74.2
Ash	0.8	5.1	0.81
Fat (ether extract)	0.6	1.5	0.22
Protein (nx6.25)	1.5	4.8	0.63
Crude fiber	0.6	3.5	0.48
Sugars	17.91	75.4	20.84
Starch	1.21	7.8	1.18
Calories per pound	3.91	1.504	4.09
Amount of edible pulp in the purchased fruit	71.0		66.0

BANANA CARBOHYDRATES

The carbohydrates of the ripe banana are mainly sugar, whi make this fruit the richest in caloric value of the common frui eaten in the raw state, with the possible exception of grapes.

A hitherto unsuspected property of the banana is its abili to combat actively the toxic effects of several types of col bacillus, such as the bacillus enteritidis. Certain experimen seem to warrant the conclusion that banana carbonate has pro erties quite different from those of cereal starch, and can assimilated in certain metabolic disorders where the latter ca not be tolerated, as for instance, celiac disease; while sprue another affliction in which benefit results from its use. Expe

nce with cases of pylorospasm commends the powdered ripe anana as being of great value, in that it mechanically thickens he food, and instead of an indigestible starch being added, as o often occurs in the treatment of pylorospasm, this substance, hen added to the other food, is easily digested, and at the same ime has a colloidal effect on the protein. Sherman places the anana among the foods in which base-forming elements preominate, and Saywell intimates that a rapid correction of an cidic urine takes place following a moderate addition of anana to the diet. The studies of Eddy have shown that the anana has hemoglobin and red blood cell regenerating potency ecause of the available amounts of manganese, copper, and iron ontained in it.[9]

CALCIUM VALUE

Experience and experimental work have proved the banana o be a very efficient source of calcium, and its acid base reaction s decidedly alkaline. Moreover, there is evidence that this fruit ot only contributes its own salt to the diet but also helps in the bsorption and retention of the calcium of other foods.

MINERALS IN THE EDIBLE PULP OF THE RIPE YELLOW BANANA

	Percent
Calcium	0.00900
Magnesium	0.02800
Potassium	0.40100
Sodium	0.3400
Iron	0.00060
Manganese	0.00082
Copper	0.00021
Phosphorus	0.03100
Chlorine	0.12500
Sulphur	0.01000
Silica	0.02380

VITAMIN CONTENT OF THE BANANA

VITAMIN A

In 1924 Munsell reported that banana pulp in daily dosage of oo mg. produced a gain of twenty-five grams in the weight of hite rats in fifty-six days when this substance was the sole source f vitamin A in an otherwise balanced diet. The commercial

banana powder also retains its high vitamin A potency, th powder-manufacturing process proving no bar to its retention Vitamin A units per ounce:—fresh pulp—70; spray dried powd —280.

CALORIC VALUES OF SOME COMMON FRESH FRUITS IN CONTRAST WITH THOSE OF THE BANANA

Fruit (Edible Portion)	*Calories per Pound*
Banana	433 to 447
Apple	285
Apricot	263
Blackberries	262
Cherries	354
Cranberries	212
Grapes	437
Grapefruit	235
Huckleberries	336
Lemon	201
Orange	233
Peach	188
Pear	288
Pineapple	196
Plum	283
Raspberries	247
Strawberries	169

VITAMIN B

With the recent demonstration that B-complex consists of tw vitamins not designated as B, B1 and G (B2), and with new methods of assay for these substances, one finds new data on th vitamin B content of foods. In 1931 Miller and Munsell re ported from experiments that spray-dried banana powder pro duced a gain of twenty-seven grams in eight weeks when from 1.5 to 2 grams supplied the sole source of vitamin B1 in th ration. This is the equivalent of from six to eight grams of fres pulp. Vitamin B1 units per ounce:—fresh pulp-x-3-14; spra dried powder—x-12-56.

VITAMIN C

In a series of growth experiments, Eddy found that the ra banana with yellow skin and green tip, given in amounts of fou grams daily, protected the vitamin, but that the same produ baked without the skin suffered some vitamin C destructio When, however, bananas were baked in the skin this C destru tion was somewhat reduced, protection against loss being con

ensated with five to seven grams. Miller and Munsell tested s high as nineteen grams of spray-dried powder daily without btaining anti-scorbutic potency, but Eddy showed protection rom scurvy from the same product when the dosage was raised o twenty grams per day. This corresponds to eighty grams of he fresh pulp. The extent of oxidation during the drying rocess is an important factor in the conservation of vitamin C. That this banana pulp may be used successfully in milk modifica-ions, in part, to correct scurvy has been demonstrated both by ohnston in Boston and Von Meysenburg in New Orleans.

Johnston reported the cure of scurvy in an eight-months-old nfant fed on a milk modification, which was made possible by hipping 200 grams of raw ripe banana into 570 cc. of milk. The infant received 120 cc. of this mixture every four hours but o other food or anti-scorbutic. The child tolerated the food, ained in weight, and recovered from scurvy in less than a month. Von Meysenburg reported a cure of scurvy in a nineteen-months-ld infant by adding one tablespoonful of banana pulp daily to he diet as the sole anti-scorbutic. Probably 50 grams in all were sed. We have found in clinical experimentation that banana ulp or powder should in general not be added to the milk odification for infants before the cereals are tolerated. A elicious banana food drink may be made by beating up the ully ripe fruit in milk and cream, after which the mass is forced rough a fine sieve or coarse muslin cloth. An egg beater may e used to advantage. In many cases banana may be substituted or orange juice, which in some instances may cause digestive psets which are probably due to the character of its protein.

VITAMIN D

The presence of this vitamin in the banana is questionable.

VITAMIN E

This vitamin is undoubtedly present, but as yet no quantita-ve estimate of it has been made.

VITAMIN G

Miller and Munsell obtained a gain of from 15 to 18 grams eight weeks with 0.49 grams of banana powder daily and 28.5 rams gain in eight weeks with 1.17 grams of banana powder aily, the quantities being the equivalent of 1.96 and 4.68 grams

of banana pulp respectively. It would seem that two to thre grams might prove the vitamin G value of the ripe pulp.

It is important to know the approximate vitamin values o the various forms of banana as contrasted with other fruits. Th following tables by Eddy may be of assistance.[9]

VITAMIN VALUES OF THE BANANA

Form of Banana	A grams	B grams	C grams	D grams	E grams	G grams
Ripe pulp..........	0.4	2.6	5	0	slight	2.6
Yellow ripe.........	0.4	?	4	?	?	?
Baked ripe in skin...	?	?	5.7	?	?	?
Baked ripe peeled....	?	?	15	?	?	?
Banana powder......	0.1	0.5–2	20	?	?	0.5–1.

THE RELATIVE VITAMIN CONTENT OF THE BANANA CONTRASTED WITH OTHER COMMON AND GENERALLY GIVEN FRUITS

Fruits	Units of Vitamin per Ounce				
	A	B, complex	B	C	G
Banana (fresh pulp)......	70–100	3.6	3.14	6	9
Apple.................	15	6.10		3	6.8
Cantaloupe.............	90	8		?	?
Grape.................	20	7.9		2	?
Lemon.................	?	10		15	?
Orange................	20	9.20		15	6.21
Peach.................	56	6.10		5	?
Tomato................	170	8.16		9	5

THE BANANA IN THE NUTRITION OF NORMAL CHILDREN

In scurvy, pellagra, and sprue, as well as in some forms colitis and intestinal fermentation, older methods of treatme may often be exchanged for the newer. In nephritis, diabete and in celiac disease, the use of the banana in a form well-lik and metabolizable is of great value.

In infant food modifications and in the nutrition of childre the full ripeness of the banana is an essential point. In ripen form its carbohydrate is assimilable, but in the unripe stage highly indigestible, for the starch has not been transformed

ugar. With the banana as with the pineapple, indeed, as with oractically every common fruit, the pulp lies in a natural sterile ontainer and the skin of the fruit, the container, if uninjured, s a natural protector against harm. Should the young pediaarician be timid in advocating banana substance in infant feedng, he need have no fear when prescribing it to older children. The vitamin A percentage in the fruit, which has been already eferred to, stands on a par with that normally present in most egetables. The banana is equal in vitamin B to tomato juice, now so dramatically featured. Its vitamin C content compares avorably with that of the orange and tomato.

Scriver and Riss made important observations over a long period to determine the value of bananas as a food for healthy nfants. They divided fifty-eight infants into four age groups ip to twenty-four months, but no infants under three months vere included. Control groups were given diets which were uitable to the age and weight of the child. Those individuals pelonging to the banana group were fed ripened pulp in place of similar carbohydrates derived from sugar, potato, and cereals. The banana pulp was administered in equal carbohydrate mounts to all. In a large proportion of the cases the fruit was aken eagerly, although a few tired of it after a time. This is he experience of many physicians, especially in celiac and Hirschprung's disease. However, the average child tires of any one food if given monotonously over a long period. The bananaed group in the experiments gained, though neither more nor ess than did the controls; the character of the stool was approxinately the same as that of the controls.[10]

H. F. Day reports excellent gains in summer classes of undernourished children when bananas, milk, whole wheat bread, and butter formed the chief ingredients of their diet. As the urine s distinctly more alkaline than acid in banana fed children, even nore so than in the case of starch and cane sugar, it seems to us vise to add this product to the diet in certain acidic conditions which result from faulty metabolism. Certain children, phlegnatic, dull, inactive, and hypoendocrinic, apparently suffer from he faulty assimilation of carbohydrates, fats, and protein, the ormer two not being fully oxidized—faults which cause a endency to obesity.

These children seem to do well on a carefully chosen mixed liet with banana substance acting chiefly as the carbohydrate ndicated. Obese adults have quite recently acknowledged that he carbohydrate of the banana is the most suitable for their condition. Children undernourished from improper feeding

and from the eventualities of unfavorable environment not only maintain weight but gain in addition from a proportiona amount of banana substance in their diet.[11]

RAW FRUIT JUICES

"Temptingly pungent," "appetizingly attractive," "biologicall effective;" these expressions are by no means exaggerations wher extolling the virtues of fruits and their juices in connectior with nutrition and the treatment of disease. Although thei nutritive properties were known even before the time of Dioscor ides and Pliny, their use in general had been disregarded an it has been only within comparatively recent years that seriou consideration has been accorded them, particularly in the feed ing of children. Scientific investigations along these lines were formerly carried out in great part by the Germans.

From the standpoint of historical interest, we are told b Geoffrey that Forestius as far back as 1750 cured himself of a severe attack of diarrhoea by eating pears. The great Linnaeus a sufferer from gout, derived great benefit from an extensive frui regimen. Even during the Civil War, obstinate cases of bowe disturbances are said to have been cured by eating peaches, the improvement being attributable to the correction of a scorbuti tendency.

Today a constantly widening field is being found for the utilization of fruits and their juices. Not only does the laymar find them delicious and pleasing, but the physician is coming more and more to appreciate their value in relation to health Many believe that the laxative effects of fruit juice are fa superior to the more purgative and dangerous mineral water in treating the constipation of infants and children. Fruit juice have an acid, alkaline, or proteolytic action, and some of them even combine two of these qualities.

Older writers divided fruits into two main divisions; flavor and food fruits. Such a division would not be considered today Hall divides fruits into three general classes; acid, sweet, and bland fruits; and apparently considers each type appropriate fo some specific form of body irregularity resulting from certair diseases. Under the acid fruits may be listed the lemon, lime grapefruit, orange, cranberry, currant, and pineapple, all being valuable in cases of hypochloridia. Sweet fruits are figs, dates prunes, and dried raisins, while pears, grapes, blackberries melons, and bananas may be considered as bland. Today it i

known that all the fruits and their juices arranged under these three divisions have valuable nutrient contents.

ACTION OF FRUIT JUICES

When the fruit juices are taken into the digestive canal they are readily absorbed and carried with the ingested food elements to the liver, where the acids and the acid radicals of the organic salts are oxidized, releasing the salts of potassium, sodium, and magnesium, etc.; which are then changed to carbonates, thereby increasing the alkalinity of the blood. These alkalis are eliminated by the kidney, the fruit juices having a decided diuretic action; the more highly acid the juices, the more marked their effect. Sweet fruit juices are those of fully ripened fruits where, in the process of ripening, the cellulose and tannic acid of the unripe variety are changed to sugar and to juice.[12] The excess of strong acids in the unripe fruit leads to the irritation of the stomach and intestines, causing colic and diarrhoea. In the juice of the ripe fruit there is less cellulose and the acids are more moderate in quantity and after their ingestion there follows a gentle stimulation of the intestinal wall.

Physicians of earlier days never added raw or cooked fruit juices to infant nutrition before the fifth or sixth month of life. Our experience has been that, properly modified, these juices can be given soon after birth, some diluted, some undiluted, and others preferably cooked. Malnurtured infants and children suffering from simple, acute, subacute, or toxic affections, certain types of intestinal disorders caused by fermentation and intoxication, loss of weight, dietetic eczemas, and constipation, marasmus, rickets, scurvy, acute and subacute rheumatism of many types, are very greatly benefited by their use. Their refreshing character, combined with their other virtues, render them invaluable in those smothering respiratory congestions encountered in bronchitis and pneumonia. They are equally of value in the contagious diseases and in congestions of the liver and gall bladder. These juices act reflexly, through metabolism, on the mucous membranes of the nares, of the sinuses, and of the middle ear. In a somewhat similar manner, they are useful in peritonitis and in certain types of ulceration, in that they aid metabolism in regulating the blood content. Their direct action as a diuretic to the kidney, and also in flushing the urinary tract, is best appreciated in pyuria, anuria, hematuria, acute nephritis, pyelitis, and cystitis.[12]

Cooked fruit juices to which sugar is added in cooking may often be of greater value metabolically in infant nutrition than the raw juices. Preserving fruits and their juices for winter consumption has been the duty of the housewife from time immemorial. Many of these old-time methods were not wholly satisfactory, as the tops of the jars were not completely air-tight Some fruit juices bear high temperatures in their preservation better than others. The black raspberry, blackberry, black currant, wild cherry, and perhaps the peach, successfully withstand high temperatures, while the juices of the strawberry, red raspberry, red currant, and the citrus fruits may, through sterilization by canning, lose in flavor and piquancy, and after a time may also lose color.

Children become accustomed to eating canned fruits, but usually prefer the raw varieties, especially in summer. Modern fruit products corporations have made great scientific advances over the older methods, by refrigeration, or by the use of a process of sterilization with carbon dioxide. Thus, with the juices of strawberry, apple, and others, their distinctive flavors are severely injured by being heated at high temperatures, and it is now possible to retain their flavors satisfactorily by keeping the juices in freezing storage at a temperature of 14° F.

It is well to remind the housewife that, although pineapple and orange juice are not greatly injured in flavor through sterilization by modern methods, they may change both in flavor and color if kept in the pantry at ordinary temperatures. Preserving them in the ice house or in the ice box, on the other hand, at temperatures ranging from 32° to 36° F., tend to retain both qualities. The juice of the orange, lemon, and pineapple are often darker in color when sterilized and subsequently kept in contact with atmospheric oxygen. If, however, these juices are kept free of this oxygen by means of moderate sterilization by carbonating them, their color then can be retained by the use of carbon dioxide. Apple juice, called by the few, liquor, and by the many, cider, will keep sweet for from six weeks to three months if chilled quickly to 32° F. after pressing before it ferments; after which time it is termed hard or sour cider. At this temperature, however, there may be found molds occasionally forming on the surface of the juice, possibly because the cans are not sufficiently filled, a condition which may be offset by the use of the ultraviolet light. In the northern hemisphere, and during the winter, when the sun's radiations are indirect and so weak that they do not benefit plant life, the necessity of raw and cooked fruit juices, with their salts and vitamins scientifically

etained for proper infant and child nutrition, becomes increas-ngly evident. The flavor of apple juice is more readily injured hrough heat than that of grape juice. Cider, to be nutritious, hould be made from fully ripened apples and should possess ull apple flavor to make it attractive to the taste. Every man, voman, and child may choose his or her favorite brand of apple rom which the cider may be made. The Northern Spy, the Vinesap, and the Baldwin, naming but a few, have a large nd enthusiastic following. Their analysis is as follows:—

PERCENTAGE[12]

	Total Solids	Malic Acid	Reducing Sugar	Total Sugar
Northern Spy..........	14.90	0.61	8.52	12.82
Vinesap.............	11.64	0.46	9.06	10.02
Baldwin..............	14.31	0.63	7.33	12.22

THE INFLUENCE OF FRESH FRUITS AND BERRIES ON THE SECRETORY ACTIVITY OF THE STOMACH

It is an intriguing clinical study to try to discover the rela-ionship between the fruit juice acids, the acidity of the stomach contents, and the amount of gastric secretion. The chemical elements of fruits undergo a constant change and are rarely stationary. One may assume from clinical observation that the greater the acidity of the stomach contents the less will be the quantity of hydrochloric acid formed. The more concentrated he stomach secretion the higher will be the acid percentage, and t is then that the highly acidified fruits and berries cause a souring effect. This may account, at least in some degree, for hat burning sensation in the pit of the stomach which the child may experience after eating highly acid fruit products, particu-arly where no animal protein food is present in the stomach.

Grunberg believes that certain fruits can be divided into two general groups, those which stimulate stomach secretion and hose which inhibit it. Among the first group he mentions melons (the pineapple melon, which probably represents the cantaloupe, or the honey dew melon of this country), the blue-black wine grape, the pineapple, peach, cherry, pear, water-melon, the dark blue plum, the cultivated strawberry, and the apple. Under the second grouping he includes many fruits which suppress gastric secretion, such as the prune, avium, grape, rasp-

berry, and apricot. He found that fruits of the first class, afte ingestion and after a short latent period, tended to excite gastric acidity, but only a small quantity of the digestive fer ments. The second class, he believes, however, after a similar waiting period, probably stimulate the gastric secretion to a mucoid condition accompanied by a lessened secretion of low acidity, but one richly endowed with ferments. One rarely sees we believe, a balance between the amount of secretion, its acidity and the quantity of its ferments.[13]

FRUIT ACIDS TRANSFORMED

It is well known that the eating of most fruits tends to render the urine less acid in character, a condition due to an excess of base forming (alkali) elements in the food. The organic acids contained in the various fruits are oxidized within the body to carbon dioxide and water, so that the net result to the organism is again in base. However, fruits such as the cranberry, prune, and plum, which contain benzoic acid or its precursors, cause the formation of urines of high acidity, a condition doubtless due, in part at least, to the synthesis of hippuric acid; and susceptible children should be restricted in an over-indulgence in these foods.

A nutritional experiment by Blatherwick and Lond may be of interest. Two healthy young women volunteered for the tests. To the one was given a uniform basal diet of 260 grams of baked potato, 440 grams of whole milk, 300 grams of graham crackers, 150 grams of raw apple, 25 grams of cheese, 45 grams of butter, 65 grams of egg. The second subject received a similar diet, but she ate no egg. After four days of this basal diet, increasing amounts of strained orange juice were prescribed. The effects of drinking these large amounts of orange juice on the urine were marked increase in the pH value (less acidity), and in creased excretion of organic acids, and a marked decrease in the ammonia output. The plasma carbon dioxide capacity of the first subject showed practically no change as the result of drinking this large quantity of orange juice. The plasma of the second subject, however, gave an increase from 59.5 cc., before the orange juice period, to 63.3 cc. at the close. Judging from these experi ments, it would seem improbable that the ingestion of large amounts of citrus fruits or fruit juices is capable of causing the production of an acid urine by overstepping the ability of the child's organism to oxidize the organic acid or acids contained in the different fruits. These conclusions do not apply to fruit

which yield other than citric acids in the body. Rather than limit orange or lemon juice to teaspoonful or ounce doses, pediatricians may feel secure in administering unlimited amounts of these juices without fear of acidotic effects.[14]

THE ABSORPTION OF THE CALCIUM AND PHOSPHORUS OF THE ORANGE

The hydrogen-ion concentration of the contents of the stomach and upper small intestine controls, to a large extent, the absorption of the calcium and phosphorus salts. Zucher, Johnson, and Barnett observed that a diet favorable to the absorption of these elements could be transformed to one producing rickets, by the addition of an alkali. According to Tilfer, the absorption of calcium is hindered by achlorhydria, hyperacidity, or by a pathologic situation in the upper small intestine. Shohl believes that a diet giving an alkaline residue in metabolism is necessary in infant nutrition when the body is rapidly developing. Several complete acid-base metabolism studies have been made to determine the effects of acid and alkali on mineral retention by the human body. Baumann and Howard, for instance, added orange juice to the diet of a man ill with scurvy and found a greater retention of the calcium, magnesium, sodium, potassium chlorine, and nitrogen, but the phosphorus remained in negative balance throughout. Incidentally, an acidotic condition of the body causes a marked effect on the retention of these mineral salts. Sawyer, Baumann, and Sherens substituted fat for an equal number of calories of carbohydrate in the diet of two normal children, boys of five and eight years of age, with the result that the alkali and nitrogen retention was much reduced. The administration of orange juice in such an instance will increase the retention and throw the balance from the acid to the alkali side.

A biologic proportion of both calcium and phosphorus in the child's diet is essential to the retention of other mineral salts which are contained in the fruit juices. Orr, Holt, Wilkins, and Borne have demonstrated in experiments on children that an excess of either salt in the diet will produce a sodium-phosphorus unbalance, in that it causes an increase in concentration of that particular salt in the blood plasma, and a proportional decrease in the other elements. In other words, an excess of sodium phosphate improves phosphorus retention but impairs calcium assimilation, while calcium chloride causes a diminution in phosphorus retention. The value of the protein found in orange

juice and its behavior in nutrition is of great importance. Al though some pioneer work has been done by Osborne and hi associates, the field for further research is a wide one.

In examining the fluid contents of the orange by centrifugin the crude juice, three layers are obtained:—"an upper layer con sisting of the fibrous shreds, a middle fairly clear, light, straw colored fluid layer, and a bottom layer, deep orange in color anc of gelatinous consistency. The top layer is skimmed off, the middle layer is poured off and filtered through paper pulp. The clear juice contains about 12 percent total solids and 0.1 percen total nitrogen, of which one-third is amino nitrogen." Appar ently it may be assumed that no nitrogen is contained in peptid combination. In the deep orange bottom layer is found 9.2 per cent of protein, all of which is located in the highly pigmente material in the chromotophores of the pulp vesicles, and it is possible to extract 10 percent of the total nitrogen from thi material.

This pectin or protein of the orange juice was formerly con sidered of no particular value, but has since acquired an im portant position in the nutrition of infants and children becaus it quite distinguishes itself from the conventional proteins, hav ing properties of unusual solubility. In the healthy child, pectir is of great nutritional benefit. In one suffering from sligh inherited or somatic dysfunction, however, it may cause gastro intestinal disturbances. Since the precipitation point of thi protein is pH 4.7 and the pH of orange juice is 4.3, it follow that under ordinary conditions the pectin is insoluble within the fruit but is present in chemical combination with the orang pigment. It is hard for one who weighs the value of ever nutrient in each foodstuff in its relation to health and to the cure of nutritional disturbances, to listen to the admonition c lay pseudo-scientists, to "eat all and every kind of food you desire, provided that such food agrees." Most people are igno rant of food values and pass their impressions on to thei children.[15]

EXPERIMENTS ON CHILDREN

Chaney and Blunt conducted experiments on two growin girls to note the effect of orange juice on calcium, phosphoru magnesium, and nitrogen metabolism. They came to the follow ing conclusions:—Calcium assimilation was found to be decic edly benefited when oranges formed a part of the diet, the in creased retention being considerably greater than the calciu

dded in the oranges, indeed, even greater than might be expected from a stimulus to retention caused by a larger calcium ntake. The increase in phosphorus retention was found to be ven more marked than that of calcium. The magnesium reention was increased, and the nitrogen assimilation proved reater after the ingestion of orange juice. Moreover, the uriary ammonia was decreased, the urinary pH, and the organic cids increased. This increase of organic acids amounted to pproximately seven percent of the citric acid of the orange uice taken.[16] Many investigators have sought to observe the ffect of the addition of orange juice in the diet on mineral and itrogen metabolism. Such a study would stimulate a growing nterest in the problems of the malnourished and underweight hild. As oranges have often been shown to produce an improved hysical condition in underweight children, and as the retention f minerals and of nitrogen by the growing organism is conidered an indication of normality and health in the child, it has ccurred to us that possibly orange juice might function by avoring a better assimilation of foodstuffs.

Newell and Miller worked with fourteen underweight children, hosen because they had shown little or no improvement as the esult of group instruction in habits of health. When 45 cc. of range juice was added to the diet of these children, with all ther conditions unchanged, the percentage of the expected gain f the group was increased from forty-nine for the four months receding the experiment, to one hundred thirty-two during he three months in which the orange juice was given. In Caliornia, a study was made on two hundred and fifty-six malnourshed children, who demonstrated a marked stimulation in rowth when oranges were eaten at a mid-morning luncheon. Even during two months of winter those children who received n orange a day in addition to their normal diet gained on an verage of one hundred and forty-one percent above the predicions, while the children who received no mid-morning luncheon r orange juice gained twenty eight percent above the expected mount. Later in the spring, the comparative gain above that redicted was one hundred and eighteen for the orange juice roup, as against eighteen for the controls. The orange contains everal components which are of importance in regulating meabolism. Compositely speaking, all fruits contain the necessary itamins and other nutrients, the orange sharing in this number.

Givens and McClugage boldly state that oranges head the list f anti-scorbutic foods. Sherman also remarks that "better rowth, higher stamina, better general health and disposition,

are induced by the feeding of vitamin C in the form of orang or tomato juice." Byfield and Daniels observed that babies wh were not gaining normally on the prescribed diet of a modifie milk formula with the addition of 15 cc. of orange juice daily gained spectacularly in growth when the amount of orange juic was increased to 45 cc. These scientists proved entirely to thei own satisfaction that the acceleration of growth was due to th relatively large amount of the water-soluble vitamin B containe in the fruit, for a similar stimulation of growth was not evidence when this vitamin was removed or weakened. One is led to be lieve also that the organic constituents of oranges may aid ir nutrition by supplementing a deficiency of minerals in othe foods and by causing a shift from the acid to the alkaline side a remedial measure for those who have eaten in excess of meat and eggs and who suffer from a rheumatic or gouty diathesis.[1-

RAW PINEAPPLE JUICE

It does seem that the pineapple has many nutritional charac teristics so pronounced that it stands out in distinction ove many fruit juices. The fresh, ripe, luscious, and pulpy pine apple has proven one of the most delectable foods in the child' dietary. It is fragrant, nutritious, and attractive, either in its original form or as a juice. The juice is clear, pungent, aro matic, and slightly tart in character. When the fruit is fully ripe the juice is sweet and agreeable. It is antiseptic in characte and is beneficial when applied on a pledget of cotton to mino affections of the nose and throat. It also contains a protei digestant enzyme. Unfortunately, in our northern markets th pineapple is often obtained unripe, having been picked green and it is therefore not edible until it ripens. The taste of th unripe fruit is often strongly astringent and at times almos caustic. Ripened on the plant, the fruit contains from ten t fifteen percent of sugar, but when picked green it contains only about one fourth as much. The fruit possesses a proteolyti ferment capable of peptonizing albuminoids. The enzyme pres ent in the pineapple, however, prevents the preparation of gelati dishes with the raw pineapple juice. The proteose potency o the fruit furnishes a ready biologic medicament in gastr intestinal disturbances resulting from animal food excess i the diet.

The fresh and the canned varieties are both sources of man vitamins and of inorganic salts. In the heat and humidity the summer, the thirsty child usually craves the raw juice rath

han the canned, for it has a slightly different odor and flavor because of its essential oils and ethers, which are present in only moderate quantity in the preserved product. The astringent potency of the fresh raw juice is rather more in evidence than is that of the processed, and in many catarrhal exudates of the throat and nose a pledget of cotton, soaked in raw, warm, pineapple juice and placed in the nostril, often proves very beneficial and soothing. In comparison with the canned pineapple juice, the raw juice finds a smaller market, for the canned product may be more readily standardized. The large pineapple growers have canning facilities not far from their fields, so that the fruit is allowed to ripen fully on the stalk, and therefore all its nutritional qualities can be retained.[17] [18] Indeed, as far as safety is concerned, the canned product is less subject to variations of heat, cold, or humidity.

METHODS OF PRESERVATION

To obviate the necessity of shipping the pineapples green and of ripening them en route rather than on the plant, the fresh fruit juice ripened at its source is now preserved scientifically immediately after cutting, and is transported in sealed containers without danger of infection to all parts of the world. The juice is expressed from the shredded fruit immediately after it is taken from the field, and processed in hygienically constructed establishments. Here it is heated to 60° C by passing it through a tubular heater, then centrifuged to remove suspended matter, after which it is poured into cans which are sealed under vacuum, heated in a cooker at 88° C for less than ten minutes, and promptly cooled. The time of heating is reduced to a minimum so as to retain the natural flavor to a maximum degree. Acid proof equipment is used. The can may be placed in a cool or cold place during the night; then two small holes are punched in the top of the can to bring the fresh raw product to view for examination. Aside from the slight reduction of vitamin C found in the raw product, the canned variety is comparable to it. The caloric content of the raw fruit is 0.6 per gram or 17 per ounce. The modern precautions taken in preserving the juice favor the protection of the vitamins A, B, and C.

The analysis of the fresh pineapple juice is as follows[19]:—

	Percentage
Moisture	85.3
Ash	0.4

Fat (ether extract)	0.3
Protein (Nx6.25)	0.3
Reducing sugars (as invert)	8.6
Sucrose (copper reduction method)	3.7
Crude fiber	0.02
Carbohydrates	12.8
Titratable acidity (as citric acid)	0.9
Calcium	0.02
Iron	0.0005
Copper	0.00017
Magnesium	0.02
Manganese	0.0003

Such a huge demand has arisen for canned, frozen, and bottled fruit juices, particularly orange juice, that several large companies now extract the juice from oranges, chill it to the consistency of soft sherbet, place it in heavy paper cartons, seal it tightly, freeze it hard, and store it until needed. The milk man can easily and safely deliver these cartons with the morning milk. The housewife simply thaws the juice before serving. Canned grape fruit juice also is growing in popularity yearly. The methods used in processing it and in the storage of the canned product are somewhat different from those employed in canning orange juice. Grape juice has a more pronounced flavor. Many communities still make the delicious raspberry and strawberry scrubs, and blackberry brandy is considered a panacea against summer diarrhoea and colic. To some extent, every housewife may preserve fruit juices, for today she usually possesses some refrigerating contrivance. In a modern electrical ice box, raw fruit juices may be kept for months without a marked change in composition, providing the temperature remains at about 14° F. In some small communities where continuous cold preservation is impossible, fruits or their juices may be kept nutritionally sound by direct freezing, at which time the ice impregnated with juice separates from the mass, and the juice becomes concentrated. As the temperature necessary to freezing falls lower and lower more and more ice forms, and the non-frozen liquid becomes even more concentrated, until finally there results a solid block of frozen fruit juice consisting of ice and of a concentrated syrupy liquid. If the block of frozen juice is now roughly broken up and centrifugalized, the syrup may be recovered from the ice and the latter discarded. Thus one may have a concentrated fruit juice possessing both the color and flavor of the original article. Incidentally, slow freezing is found to be more satisfac-

tory than rapid freezing. For instance, in this type of freezing the crystals of ice formed are large and at the end of the freezing process consist of long thin plates reaching in toward the center of the container, while in the ice cream freezer the ice forms a finely melted mass from which the concentrated juice is separated with difficulty. A temperature of 14° F. is sufficiently low to give the concentrated juice a solid content of about fifty percent. Such juices ferment very slowly at room temperatures, the presence of sugar and acid greatly retarding the growth of microorganisms. In preserving strawberries for winter use, the fresh fruit may be markedly injured and the familiar "cooked strawberry" taste bought about when the juice is sterilized by heat, as is generally done at the present time. Fresh orange and lemon juice may be processed in the same manner as the pineapple.[20]

CERTAIN OBJECTIONS TO THE USE OF FRUITS

Many believe, although wrongly, that when nuts are eaten together with fruits the latter may cause the blood to become acid and, in consequence, to cause acidosis. Fruits contain certain organic acids, but they also possess an abundance of potash and other alkalis which counteract these acids to some extent. Moreover, the fruit acids, while in the digestive tract, unite with the alkalis already present to form neutral salts, which pass directly into the blood and become carbonates of potash, sodium, and lime, thus rendering the blood alkaline. This knowledge aids in the treatment of acidotic conditions, whether inherited or acquired. Haig believes that fruits have a double action, one acid and the other alkaline; but their total effect may be either neutral or alkaline. Not a few fruits cause a retention of uric acid during their period of acidity, and the uric acid may not be completely neutralized by the alkalis present. Certain organic conditions may arise in children when strongly acid fruit juices are taken in cold damp weather or when the fruit is eaten unripe and out of season. Subjective symptoms of rheumatism have been noted. Haig recommends that fruits be not eaten before mid-day, for by that time, he thinks, the stored up uric acid of the day before has had time to disappear, having been in large part excreted in the urine instead of being retained or precipitated by the fruit acids.[21]

Hermann suggests caution in the drinking of water after eating fruits. He considers such a habit dangerous, as the gastric secretion cannot penetrate the body of the fruit, since the water acts

as the barrier. One may possibly get an intestinal disturbance, he says, possibly a poisoning, an anaphylactic, or an endocrinal shock. We have never observed these drastic reactions, however. Occasionally one may see patients who complain of severe abdominal pain and perhaps of a water diarrhoea following the ingestion of a large quantity of highly acid and pulpy fruit, but these disturbances soon disappear.[22]

Heisler remarks that when eating apples and highly acid citrus fruits without an admixture of other foods he himself has occasionally developed a huskiness and loss of voice resonance, but when other foods were added to the diet to balance it these disturbances gradually subsided. During the attacks he experienced no pain at all. Occasionally one may have observed a slight swelling of the parotid gland in children, which is felt as a rather hard lump and is slightly painful to the touch, so that children lying on the affected side of the face are restless and uncomfortable during sleep. In nervous and in susceptible children, a somewhat similar condition may occur after the eating of unpeeled, fully ripened, but tart apples, indeed, sometimes after grapefruit and logan berries, when the glands of the anterior cervical chain in the neck become slightly swollen and rather painful. When the highly acidified fruits are omitted from the child's diet, the condition clears up at once. These untoward conditions are so uncommon that disordered metabolism may be the cause.

Older children may complain of gastric pain or of a mild headache which may be attributed to the immaturity of the fruit eaten or to the kind of fruit to which the child is not accustomed.

The high acidity of certain fruits, particularly the citrus fruits and their juices, together with a lowered secretory activity of the glands of the stomach, may constitute one objection to their administration. The effects of fruits and of their juices on divergent groups of children invites further clinical research.[23]

CARBONATED BEVERAGES

In or about the year 1793, Joseph Priestly impregnated water with gases. Originally this mixture was used for medicinal purposes. Gradually, substances similar to those at present in use were added. It is remarkable how little is known by the public of the nutritional qualities of carbonated beverages. With the passing of years however they have grown in popularity as beverages. This is attested by the present enormous annual con-

sumption of 13 billion half pints.[23] Into the huge "pop" bottle go 250,000 tons of sugar, 5 million pounds of fruit acid, 50,000 pounds of harmless artificial coloring matter, 1,000,000 gallons of flavoring extract, and 400,000,000 gallons of carbonated water.[24]

Carbonated beverages have increased in numbers, in goodness, and in variety. Some of them, such as sparkling bottled cider and grape juice, are pure fruit juices, others are made from synthetic substances. The color, sweetness, and tartness of these drinks are often improved by the addition of small quantities of non-injurious artificial coloring matter, such as sugar, citric, tartaric, or other food acids. Their safety is assured by the Federal Food and Drug Act, which requires that the analysis of the contents be placed on the label of the bottle. High sounding titles such as crême de menthe, benedictine, vermouth, kimmel, and others are merely pseudo names.

Certain varieties of beverages find favor in one section and not in another. Ginger ale, root beer, and sarsaparilla sodas, while disappearing from the soda counters in one locality, may increase in popularity in another. Children are often individualistic in their tastes and preferences. Some prefer fruit juice beverages with or without sugar. Some are attracted to a drink which makes a noise. Carbon dioxide makes the drinks fizz and not only gives a pleasant, sharp taste to the contents, but at the same time insures a more or less pasteurizing effect to them.

Legally controlled and scientifically processed as at present, children need not be deprived of the enjoyment of soft drinks. When the warm, humid weather of summer approaches the child is attracted to the bottles of "pop" alluringly displayed in shop windows and on soda counters.[24]

COMPOSITION

Carbonated beverages should be classified not only as beverages, but considered as health foods as well. With increased knowledge of food substances, with purity of materials, and with scientific processing, and with improved methods of handling, bottled drinks are not only nutritious but they may be enjoyed with safety. Their vitamin and caloric values are high and their stimulating effects on digestion and metabolism considerable.[25]

The base of all sodas is practically the same, and consists of sugar, water, flavor, color, carbon dioxide gas, inorganic salts, and fruit or phosphoric acids. The ingredients used to flavor soft drinks are fruit juices and aromatic substances derived from

various parts of plants, herbs, and spices, such as heads of flowers, cloves, chamomile, vanilla beans, the peel of citrus fruits, from seeds, grains, and from paradise and celery. Various other substances are contained in the roots of ginger and sassafras, in the bark of the wild cherry and that of cinnamon, and in the stems and leaves of sage and peppermint.[24]

Synthetic flavors are prepared from extracts rather than from natural sources. They can, however, be just as pure and wholesome, and are somewhat similar to those of natural substances. Many natural flavors are perishable and often too delicate to be used in processing.[26]

The sugar content alone marks these beverages as foods. The form used in the composition of bottled beverages is invert sugar. Under the combined action of the citric and carbonic acids in the fluid whatever sugar is present is changed into glucose or dextrose. Where no fruit acid is added the carbonic acid alone is enough to produce invert sugar, although at a slower rate.[27]

From an analysis of 468 samples of beverages from all sections of the country, the average sugar content was found to be 11.19 percent. As a class however, ginger ales are low in sugar, testing only 9.63 percent. Soft drinks are colored with caramel and every "batch" of color developed must be submitted to and approved by the United States Department of Agriculture.

The carbon dioxide content has a well recognized dietetic value, in that it reflexly stimulates the flow of the digestive juices and increases the absorption of fluids from the intestines and abets their excretion through the kidneys.[28] The acids used are mainly citric, tartaric, and phosphoric. Lemons supply most of the citric acid, and grapes the tartaric, but acetic and lactic acids may also be present. Tartaric acid is not assimilated as well as the citric and lactic acids.[27]

NUTRITIONAL EFFECTS

When children are recovering from nutritional disturbances and when nausea and gastric irritability are present, the carbonic acid gas content of bottled beverages tends to allay them. The invert sugar contained in the mixture provides energy, and assimilation of food is hastened. Many normal children drink an insufficient amount of water for their metabolic needs. Soft drinks are often more to their liking and they will drink bottle after bottle with gusto. An over-indulgence rarely occurs.[26]

When drinking the desired beverage much of the gas is probably lost, a part however is absorbed and taken up by the blood

stream, another portion remains in solution, while still another part is recovered by the mineral elements in the blood to form carbonates. A portion of the carbonic acid gas content of the beverage is eliminated by the lungs.[27]

Carbonated beverages help to maintain the alkalinity of the body and thus to prevent acidosis. They have a mild stimulating and exhilarating effect on the organism. They act to promote absorption of the nutrients contained in them, to increase the blood supply to an organ, to stimulate the flow of saliva and of the digestive juices, and to improve digestion and metabolism.[27]

SANITATION AND HYGIENE

The tools, vessels, and materials employed in the processing of soft drinks are not only rendered clean but are handled with sanitary and hygienic precautions. The proper sterilization of the vessels and containers used, together with the preservative action of the carbon dioxide gas, the association of heat and alkalis, the absence of harmful atmospheric conditions, the presence of acids, and pure water insure a safe product.[28]

When travelling there is always danger from water pollution. Carbonated beverages not only prevent the growth of microorganisms, such as those causing typhoid fever, in their containers, but they also help the fluid content to be germ destroying.[27]

EXPERIMENTATION

Carefully controlled experiments with rats at the Iowa State College, extending over a period of about two years, under the auspices of the American Bottlers of Carbonated Beverages, demonstrated that when a carbonated beverage was added to an adequate basal diet these animals grew as well if not better than those subsisting on this diet alone. Reproduction and the growth of the young progressed better than with the controls which did not receive the combined ration. However, these beverages should never be substituted for other foods which are instrumental for body growth. It was found in these tests that the use of bottled drinks increased the total water consumption but did not decrease that of milk, indeed rather increased it, and the rats which had milk in their diet showed the best results.[28]

EXPERIMENT I

In this experiment 3 lots of rats, of six animals each, were used. Each lot was given all it could consume of ground rolled

oats and whole milk. In addition, some received grape carb- nated beverage and water.

Table 1, following, shows the consumption of each part similar data which were obtained in several experiments.

TABLE 1

	Ground Rolled Oats	Whole Milk	Grape Carbonated Beverage	Water
Lot 1	7.0 gm.	15.10 cc.	—	5.50
Lot 2	5.0 gm.	21.80 cc.	20.60 cc.	—
Lot 3	6.4 gm.	18.7 cc.	19.90 cc.	2.40 cc.

Note that the milk consumption in Lots 2 and 3, which r- ceived the carbonated beverage, was not decreased. Rather i this particular experiment there was a definite increase. It wi also be noted that the total consumption of liquid (water) increased in lots receiving carbonated beverage.

Reproduction and rearing of young is an index as to healt and condition of the animals. Table 2 gives this record in sun marized form.

TABLE 2

	Total No. of Litters	Total No. of Young	Total Weight of Young	Average Weight of Young at Birth	Average Weight of Young at 30 Days
Lot 1	19	165	704 gm.	4.3 gm.	41 gm
Lot 2	19	167	844	5.1	45
Lot 3	21	196	951	4.9	46

This chart shows that the animals receiving carbonated beve ages raised as many litters, produced more young, with a great weight of young, a greater average weight at birth, and a bett average weight for each young animal at the end of thirty day Lots 1, 2, and 3 were given the same rations respectively as Table 1.

EXPERIMENT II

The statement has been made that a bottle or two of carbonat beverages for a child might result in the child having a dim ished appetite for other foods.

Further examination of Table 1 in Experiment I shows that he consumption of carbonated beverage in proportion to the reight of the animal was great. In other words, in proportion) their other food these animals consumed much more of the arbonated beverage than would be normally consumed by a hild of 12 to 14 years, and without decreasing their consumption f milk. A child 12 years old requires about 2,000 calories a day. n average bottle of carbonated beverage contains approximately oo calories. If the child consumed one bottle per day, it would ean about 1/20 or 5 percent of the energy required would be btained from the bottled beverage.

Experiment II was planned to determine whether or not caronated beverages would diminish the appetite for other foods. n this experiment rats were given the rolled oats and milk nd amounts of carbonated beverage equivalent to one, two, hree, and four bottles per day, on the basis of a child of about 2 years of age. The data obtained from one two-weeks period f this experiment, which lasted for 12 weeks, are given in Table 3.

TABLE 3

Lot No.	Equivalent Carbonated Beverage Offered	Rolled Oats	Whole Milk	Grape Carbonated Beverage	Water
21	Control	5.2 gm.	6.6 cc.	—	5.3 cc.
22	One Bottle	5.7	6.3	2.5 cc.	6.1
23	Two bottles	4.8	7.3	5.0	4.7
24	Three bottles	4.4	7.2	5.9	3.3
25	Four bottles	4.5	8.0	7.7	4.5
26	Not limited	4.5	8.4	5.2	3.9

It can be observed from examination of the data in Table 3 hat the consumption of carbonated beverages in amounts up to he equivalent of four bottles per day had no influence on relucing the consumption of milk. In fact, with this particular ot the reverse is quite true, because an increased consumption of nilk is shown as the amount of carbonated beverage was increased.

Table 4, following, gives the data of Table 3, calculated to he calory basis. Here are given the total caloric consumption er rat per day, the calories obtained from the beverage, and he percent of the total calories represented by the carbonated beverage.

TABLE 4[28]

Lot No.		Total Calory Consumption	Calories from Beverage	Percent of Total Calorie from Beverag
21	Control	23.0	—	—
22	One Bottle	25.8	1.3	5
23	Two Bottles	24.5	2.5	10
24	Three Bottles	23.4	2.9	12
25	Four Bottles	25.2	3.8	15
26	Ad Lib.	24.3	2.6	11

CANNED PINEAPPLE

In calling special attention to canned pineapple, it is not wit the idea of minimizing the value of the raw fruit, but rather t show that the processed product possesses food properties ofte unrecognized. In the nutrition of infants and children it is c even greater importance than the raw pineapple. For exampl the antiseptic quality known to be characteristic of raw pineappl juice has been disputed in the processed product. Yet Serag and Hunwicke inoculated a tin of pineapple with spore bearin aerobe and kept it at a temperature of 37° C. for three week When the tin was opened the contents were found to be in goo condition and their citric acid content had altered only fror 0.42 to 0.46 percent. Subsequent microscopic examination showe no bacterial increase and the inoculated strain was recovered wit great difficulty. Thinking men realize that while spore-bearin bacillus types such as the aerobes, the spore-bearing aerobes, c the thermophilic bacteria may be of no real significance as cause of ordinary unsoundness in canned fruit, as for example in th pineapple, yet the yeasts, coccoid bacilli, the gas-producing nor spore bearing bacilli, and the micrococci, all of which have com paratively low resistance to heat, might make the fruit unfit fc consumption. We are safeguarded, however, against these micr organisms by the processing methods of responsible food concern

Probably no one fruit has made such popular advances all ov the world as has the pineapple, for as now processed, it can l eaten with impunity in any region, hot, cold, malarial, feve ridden, or otherwise, where the raw variety is inaccessible.[29]

Today, great care is taken in the culture of the plant, in bree ing, selection, and fertilization, and in the sun-ripening of t fruit and its preservation. The rapid rate of autolysis in t ripe, raw fruit is initiated by a protease called bromeline, whic

active in acid, alkaline, or in neutral media, but is inactivated uring canning. This fact presents obstacles which in many cases present are apparently insurmountable when the perfectly pened raw fruit is shipped from the regions where grown to istant shores. Hence, the full dietetic values of the pineapple all seasons of the year and in all climates can be guaranteed nly in the form of the canned whole fruit or of the raw, scientifially preserved pineapple juice. The researches of Killian and thers have confirmed this.

It is acknowledged that at all periods of life the diet should rovide vitamin A, which is found in the pineapple in abundance; is the essential instigator of growth and an aid in the balancing metabolism. It must not be forgotten also that vitamin A ds in resisting infections and in halting bacterial invasion. Ioderate colds and mild attacks of rhinitis may be effectively necked by adding pineapple juice and milk to the child's diet. Iiller found that both fresh and canned pineapple were valuable ources of Vitamin A.

Vitamin B, B^1, another nutrient contained in this fruit, is not nly almost a panacea against beri-beri, but is necessary for rowth, as well as for stimulating the appetite. For little patients uffering from anorexia following debilitating diseases, the pineople products have proved invaluable. Since the knowledge of ne actual need of the child for vitamins has increased, it has een felt that to maintain the child in health it is best to add ne vitamins to the dietaries in rather large amounts. As yet, no ne has discovered wholly debatable contraindications to giving tamins in such quantities. It may be proved later, however, nat an over-abundance may follow the same path as an overoundance of other food nutrients. Many pediatricians advocate n over-supply of vitamin G (B^2) in the diet as provider of noral growth and nutrition for infants and children. Bourquin nd Sherman have described tests in which nine grams of canned ineapple, in addition to a basal diet, when fed daily to albino ts, provided enough of vitamin G to produce an average weekly ain of 3.0 grams in the test animals. Hence it must be inferred nat one ounce of the contents of the can contained five units of nis vitamin or eleven units for one hundred grams.

Vitamin C is also strongly potent in the pineapple, and many nild cases of scurvy accidentally discovered in clinics and hositaI wards may be treated with the canned product. Miller conuded from experiments that the minimum protective dose of unned sliced pineapple against scurvy was from four to five rams and of the canned crushed fruit from six to seven grams.

Since vitamin C is very sensitive to destructive agents and as i is known to vary in amounts in raw fruits and vegetables at di ferent seasons of the year and in different localities, there is grea satisfaction in knowing that the canned product, which is un form in nutrient character and in vitamin content, may be sup plied to infants and children throughout the year.

MINERALS CONTAINED IN THE PINEAPPLE

The milk of infant food modifications lacks adequate iron fo a proper formation of the oxygen-carrying group in hemoglobi and for chromatin substances which regulate the vital activitie within the biologic cells. But iron in minute amounts and i forms other than hemoglobin, as well as copper, admittedl serve as catalysts for the oxidation-reduction processes throug which the potential energy of oxidizable food stuffs is mobilize for the support of the activities of the various tissues of the bod Under normal conditions the pineapple readily supplies this iro deficiency. Incidentally, even under the most favorable circum stances, the amount of the iron salt which the infant inheri from the mother is soon exhausted and must be restored in th mother's milk or in proper cows' milk feedings. Should this in take not correspond with the excretion there soon results a de crease in the hemoglobin of the blood, and those depressing case of nutritional anemia are produced.

The necessity of iron and other minerals in the child's diet ca never be over-emphasized. Leichsenring and Flor have demon strated that in relation to body weight pre-school children nee as much iron for maintenance and growth as do adults; namel 0.2 mg. per kilogram. These authors believe that the child's die should supply 0.52 mg. of iron per kilogram of body weight i order to allow a fifty percent margin of safety. There is n better source of natural iron and of other minerals than th vegetables and fruits, and there is no better single source tha the juice of the pineapple, raw or canned.

On account of its high water content and low proportions protein and fat, it may be given to any child, well or ill, with in punity. Obviously it cannot replace staple foods of high calor or high protein value, but it gives to the ingested food no add tional bulk. A combination of iron and copper is essential f hemoglobin regeneration, and manganese is held as a suppleme to them in the diet. The pineapple contains all three salts, a in respect to the iron content alone canned pineapple ranks ve high in the series of thirty-six fruits. In fact, the proportion

opper and manganese to iron in the canned product is greater han that contained in other fruits possessing a greater iron conent. The percentage of iron, or of any nutrient in a food, is not i itself an adequate measure of the value of that food in meeting ne iron and other requirements of the child's organism. No ne should remain ignorant of the fact that the value of the ineral or other nutrient content in the food is not only deendent on its nutritive qualities, but on its importance to the iologic cells in metabolism. Many canned fruits, and especially nned pineapple, exert a great hemotogenic effect on the child's ganism, undoubtedly because of the relationship of the nutrive qualities of other foods.

Milk, cheese, beans and vegetables yield large amounts of calum and phosphorus for the building, preservation, and strengthning of the child's bones and teeth. The pineapple also adds the diet appreciable amounts of these substances. Data have een furnished which show that an average serving of canned neapple to the amount of eight ounces, for instance, which also cludes the fruit pulp and syrup, supplies 70 mg. of calcium nd 26 mg. of phosphorus to the diet. This calcium supply is quivalent to that of about two ounces of whole cows' milk, ut the amount of phosphorus contained in the canned fruit in omparison is equivalent to that in only one ounce of the corsponding milk.

DIGESTIVE PROPERTIES

The digestibility of the pineapple deserves more than passing otice, for beside its other estimable properties it possesses proin digestant qualities of no mean order. As far back as 1891, hittenden demonstrated in the raw fruit the presence of a roteolytic enzyme which was active in neutral, acid, or alkaline edia. Recent work of Woksman, Selman, and Davison has own that the juice representing the entire unfiltered fluid, eshly frozen, gave in this frozen state an average figure for otease activity in an acid medium, at (pH-3.0) of fifty-nine, and ty-six in the alkaline counterpart of pH 7.4. They found the erage result to be one hundred percent higher than that conlered normal for gastric contents. It was also discovered that e average figures for a similar number of samples of the canned ice were 1.0 at pH 3.0 and 4.5 at pH 7.4. It would appear that e canned juice contains neither an active acid nor an active kaline protease.

Pineapple juice may be safely given in those inherited gastric

dysfunctions of either hyper- or hypo-acidity, and in those m dysfunctions, celiac and Hirschsprung's diseases. Experim made on living subjects showed that the consumption of can pineapple juice under the Rehfuss standard test produce more rapid rate in the secretion of acid during the first h of gastric digestion, but a more rapid rate of the neutralizatio the acidity in the second hour.

In our experience, the addition of canned pineapple juic the standard meal of children tends to speed up the wh process of gastric digestion in normal individuals. It does same with infants on milk modifications. In many pathol conditions of the digestive tract, this juice may be given advantage. The activities of the protein-splitting enzyme of gastric contents are stimulated by the addition of pineapple j in the digestion of meat, eggs, cheese, and legumes.[30]

Being cognizant of the mild antiseptic and proteolytic quali of the canned fruit, one may embark on a speculative jour down the alimentary canal and study those forms of nutritic diseases which are amenable to treatment. The survey begins catarrhal and aphthous stomatitis and thrush, and farther do gastric catarrh because of faulty stomach secretions, often cau by excess of animal proteins. In such cases canned pineap juice acts as a proteolytic agent. Much the same may be sai acute intestinal indigestion of the upper tract resulting from unbalanced food intake and because of an excess of unassimil animal proteins. In celiac disease, where the protein intak necessarily high, pineapple juice is of great advantage, part larly if alternated with orange juice. In acute intestinal an gastro-intestinal diarrhoeas and in the so-called summer rhoeas of children, the juice of the pineapple has given g satisfaction. In the same manner one may speak of constipat also often symptomatic of protein overabundance. Owing to pineapple's astringent and proteolytic properties, pin wo round worms, and even tape worms find an inhospitable As pineapple juice rates high in its vitamin and salt conten reacts favorably on the liver cells in mild cases of acute catar jaundice.

In contagious diseases it is an aid to recovery through its gizing, laxative, and diuretic action. In epistaxis due to di disorders and to climatic changes, pledgets of cotton soake canned pineapple juice may fill an emergency. In acute rhi pineapple juice, raw or canned, dropped into the nasal pass on account of its astringent and antiseptic qualities, may in cases lessen the watery discharge (Adria).[31] In an emergency

ice applied on cotton may benefit acutely inflamed tonsils. mple cases of inflammatory and catarrhal pharyngitis and acheitis may also be added to the list.

THE PINEAPPLE IN RENAL FUNCTION

Magraith has reported a prompt and definite diuresis brought bout by the consumption of canned pineapple juice in a patient ho exhibited an edema coexisting with cardiac insufficiency. his condition was the result of congenital heart disease in which rdinary diuretics and the drug novasural had proved ineffectual. ndoubtedly many clinicians have seen renal dysfunctions run ue to dominance in heredity, while others are recessive in char- ter. The mechanism of the action of pineapple juice on the te of urea excretion is at present writing unknown. It can said, however, that the sugars contained in the fruit may play me part. Renal function has been estimated in terms of the te of the excretion of the principal nitrogenous waste product, rea. Tests have proved conclusively that pineapple juice in- eases the rate of elimination of urea above that for similar olumes of water or of sugar solutions acidified with citric acid. anned pineapple acts as an aid to kidney function by stimulat- g the kidneys to eliminate waste products from the blood.

In the study of any acute renal disease in infants or children, ten of obscure origin, the possibility of an excess animal pro- in diet as the cause should be considered. Is it not at least rongly suggestive that the Indian troops in India, who do not t meat, never have trench nephritis, while this condition is very ommon among the French and English regiments in many parts the world, who are heavy meat eaters?[30]

In the United States, dietary excesses, faulty housing, the use highly improper and indigestible foods, rather than those easily igestible and metabolizable, and the sudden climatic changes, l predispose to many acute nephritic diseases in the young, for mmunity is lost and resistance to protein poisons is lowered.[31]

CANNED PINEAPPLE AS AN ALKALINIZING AND ANTI-KETOGENIC AGENT

In the treatment of ill-conditioned children and of those at uberty, who are especially subject to an unbalance of base form- g elements, canned pineapple may be classified among the foods hich yield a preponderance of these bases when oxidized in e body. In fact, after cell incineration the pineapple leaves an

ash of which the alkalinity has been determined by citration against normal acid, and the results are expressed in terms of M of a standard acid required to neutralize the ash from 100 gm. o this fruit. Fifteen analyses were made on samples of six brand of the fruit, from which an average figure of 5·9 was obtaine for the combination of fruit pulp and syrup as found in th can. The free acidity of the pineapple has been determined in terms of citric acid. In thirty analyses of six brands of the canne variety, the syrup being separated from the fruit pulp by filtra tion through muslin cloth, there was an average acidity of pH3.47 With delicate and extensive experimental technique on live sub jects, it was determined that during the two hours followin the consumption of the pineapple all the subjects tested ex hibited an increase in the plasma alkaline reserve, which reache its maximum at the end of the second hour, and varied from 2- to 6-8 volumes percent. The known influence of the consumptio of this fruit on the alkaline reserve of the blood plasma is th availability of the potential energy in its carbohydrates for oxida tion. If R represents the balance between anti-ketogenic an ketogenic factors after oxidation and during the hourly period following the consumption of the pineapple, it may be logicall supposed that an increase in the value of R after the ingestio of a foodstuff would indicate an anti-ketogenic reserve, which ma correct an existing ketosis or may protect against the developmen of it. Obviously, the rise in anti-ketogenic balance following th eating of the pineapple or its juice is due to a perfect oxidatio of the biologic sugars contained in the fruit.

It should not be forgotten that the blood plasma of the chil in health is normally slightly alkaline in reaction. The smal excess of alkali over acid in the blood is essential for its natura function and is expressed in the term, "alkaline reserve of th blood plasma." The maintenance of this alkaline reserve withi health limits depends obviously on the quantity and especiall the quality of foods in the diet. Foods may be classified in ger eral as acid formers or base (alkali) formers, in accordanc with their observed or calculated effect on the balance betwee the acids and bases of the body. What does an unbalance fro faulty nutrition portend? It will be remembered that the fa are necessary and valuable foods, as they yield the greatest quant ties of heat and of water during their oxidation in the tiny cel But a simultaneous oxidation of the carbohydrates (glucose) i the child's body is essential to assure a complete combustion the fats to carbon dioxide and water. In the absence or deficien of this burning up of the carbohydrates, the fats are oxidized

at they completely form what is known as ketone bodies, some which are acids. This irregular process, which may take place ill-nourished children who are afflicted with a dysfunction, is lled ketogenesis, and it may and often does result in an idosis, which means that there is a decrease in the alkaline serve of the blood plasma below the normal level.

On the other hand, food factors which during this oxidation omote the complete combustion of fats are said to be anti-togenic, in that they protect against the development of keto-nesis or acidosis. The principal anti-ketogenic foodstuffs are e carbohydrates, starches, sugars. Canned pineapple, both the uit pulp and the sugar, are markedly anti-ketogenic, as they pply food nutrients which are easily assimilated and are omptly oxidized to supply an anti-ketogenic balance between id and alkali and thus aid in correcting acidosis. Therefore, ving to its anti-ketogenic and alkalinizing properties, canned neapple helps to maintain the normal alkalinity of the blood d to preserve the child in health.[30]

DRIED FRUITS AND VEGETABLES IN NUTRITION

In the hinterland of Canada and in some parts of New Eng-nd, many people still sun-dry apples, plums, and other fruits, well as vegetables, on wooden racks and leave them to dry in e sun, where they are subject to dust storms, insects, and to lfering youngsters.

When surrounding conditions are ideal, however, sun drying an excellent method for evaporating practically all fruits and getables, both early and late. Sun drying is practiced in hy-enic surroundings in California, throughout the southwest, on e Great Plains, and in many parts of the south. In these calities, berries, cherries, squash, apricots, pears, apples, plums, aches, sweet corn, and pumpkins are sun dried in large quanti-es. They contain, when desiccated, nearly the same nutrient oportions; and, with a little water, may be restored almost to eir original form. Vegetables contain from 75 to 95 percent of ater, which is easily removed by drying. Even the best of food oducts, if stored too long, are subject to insect and to bacterial vasion, as well as to damage by physical and chemical agencies. ilk may be dehydrated, but with removal of the fluid content e remaining dried mass may easily spoil.[32]

Drying (evaporation or dehydration) reduces the product one urth to one ninth of the fresh material. Dried products can stored for long periods without the use of hermetically sealed

containers. All fruits and vegetables cannot be dehydrated b sun drying. Home drying depends on the temperature of th air and the percentage of moisture in it. If the surrounding ai is moist and of moderate temperature and no currents of air ar present, the product will dry slowly; whereas if the air is dry, th temperature high, and with air currents circulating, the produc will dry quickly.

Commercial dehydration permits of greater uniformity. Rapi drying is secured by increasing the temperature of the air, b quickening its rate of movement, and by forcing currents of ai at regulated speed over the substance. The flavor and quality o fruits and vegetables are best preserved by this method.[33]

Fresh fruits have been sun dried for centuries, and suc products have been discovered in the tombs of the Pharaoh Figs, dates, and raisins are mentioned in some of the oldest writ ings known. Those originally desiccated fruits are now supple mented by prunes, peaches, apricots, apples, etc. Due to thei high sugar content, fruits may be held longer in storage tha vegetables. Fructose, the natural fruit sugar, seems to act as defense against bacterial destruction; however, spoilage may re sult from atmospheric conditions.[32]

Dried fruits such as raisins, prunes, figs, peaches, apricot apples, and pears are excellent and immediate sources of energ because they all contain fructose. Sucrose, or table sugar, unlik fruit sugar, is a double saccharine, and it must be acted upon b the digestive juices and changed to a simple sugar before it ca be metabolized.

PERCENTAGE OF FRUCTOSE IN COMMON DRIED FRUITS

Raisins	75	percent
Figs	56	"
Apricots	57	"
Pears	47	"
Prunes	39	"
Peaches	39	"

The mineral salts found in these fruits are calcium, phosphoru iron, magnesium, potassium, sodium, copper, chlorine, and su phur. Iron, to be effective in the building of hemoglobin, mu be accompanied by copper. Dr. Elvejhon places dried frui fourth on the established list of copper bearers, and fresh fru twelfth. Whole-grained cereals are in third place, but in t

e milling process they lose much of their copper content. ost dried fruits have an advantage over prunes in that at no ne do they lose their minerals.

Of all the fruits, raisins are undoubtedly the most alkaline, t dried figs, apples, peaches, apricots, and pears are also alkaline their reaction. These fruits, therefore, may be prescribed in e acidotic conditions of childhood. Prunes are an exception, ving an acid ash and containing substances which form hipric acid, rendering the urine acid. Robscheit, Robbins, and hipple claim that in treating severe cases of anemia these dried oducts are particularly effective in promoting hemoglobin reneration, and in this respect they are far superior to dairy food oducts.[34]

The fibre content of dried fruits, while of no actual food value, s as roughage and tends to stimulate peristalsis. The seeds of e fig and the skin of the prune are very effective in preventing nstipation in older children.

The fats and proteins of these dried substances are unimpornt, being present in larger amounts in other foods.

Dried fruits also contain vitamins. For example, the prune ntains vitamin A, raisins, prunes, peaches, and apples contain amin B, while apples and peaches contain vitamin C also. nese delicious fruits may be eaten raw or in desserts such as s, cakes, puddings, jellies, and salads.[34]

VALUE OF PRUNES IN NUTRITION

Many misleading statements have been and are being circued concerning the place the prune holds in the nutrition of ldren. Since these false ideas have been of long standing, and cause of constant repetition, they have to a certain extent been cepted even in supposedly well-informed circles. Briefly, the tritional properties of dried fruits in general are as follows:—

Their laxative principle
Their vitamin and mineral content
Their energy value
Their hemoglobin and red cell values
Their restoration potency, due to their effect on the alkaline reserve.[35]

LAXATIVE PRINCIPLES

The laxative principle of prunes is due not entirely to the ion of the fruit in bulk, but to an active element which stimu-

lates the intestine. Nor are these properties the result of th colloidal or emollient effects on the intestine, but rather, accord ing to Magnus, Macht, and Eddy, they depend both on an activ principle in the prune which is broken down by strong hydroly sis and also on certain inherent chemical and physiologi properties, which are similar to dehydroxphenylisatin and t caffeic and chlorogenic acid.[36]

VITAMIN AND MINERAL CONTENT

California prunes are not only excellent sources of the vita mins A, B, and G, but they also contain in considerable amount the mineral salts, which include calcium, potassium, phosphoru sodium, iron, magnesium, manganese, copper, chlorine, and su phur. Among the commoner fruits they rank highest in iron an copper content, and in addition they possess an appreciabl percentage of manganese. Prunes, therefore, may be considere a valuable asset in nutritional anemias.

ENERGY VALUE

The immediate energy value of prunes must not be overlooke especially in the quickening of organic function in phlegmati and ill-nourished children. This result is because of their hig content of easily assimilated sugars which produce their effe on the alkaline reserve.[35]

The energy value of the prune is easily confirmed by a surve of the composition of their edible portion.[35]

	Percentag
Moisture	18.4
Ash	2.2
Alkalinity of water-soluble ash (cc. N-acid per 100-grams prune flesh)	20.5
Alkalinity of acid-soluble ash (same)	7.3
Protein (N x6.25)	2.8
Water-soluble solids	78.0

THE CARBOHYDRATES OF DRIED CALIFORNIA FRENCH PRUNES

French prunes are recognized as an outstanding variety a their carbohydrates are important in the nutrition of childre

he fertility of the soil in which they are grown exerts a marked fluence on the number, the purity, and on the nutritional lue of their nutrients. Prunes from various districts in Cali-rnia differ in sugar content, in specific gravity, and in other ialities, much as do oranges from various regions of Florida, id apples from different localities in Vermont. In the warmer cramento and San Joaquin districts the ratio of dextrose to vulose was found to vary more than two to one, in comparison ith a ratio less than two to one in the prunes from the cooler nta Clara and Napa districts. This gives rise to the question to whether the ratio of dextrose to levulose is naturally higher prunes from the warmer districts, or whether some of the gars are lost during the process of drying the fresh fruit in e sun and because of higher drying temperatures. Sucrose, arch, and the hemicelluloses all vary considerably in amounts the different samples from unrelated districts. The hemicellu-ses, or pentose sugars, and also the pentosans form a large part the unmentioned and often unrecognized fraction of prunes so iportant in nutrition. The dextrins are present, but apparently only negligible quantities. Biologic chemists report other con-tuents of prunes; namely, pectin, lignin, and cellulose.[37]

CARBOHYDRATES OF DRIED PRUNES [35]

a. Reducing sugars	44.3
b. Dextrose	29.7
c. Levulose	14.6
d. Sucrose	2.2
e. Starch	1.0
f. Dextrin	negligible
g. Pentosans	2.7
h. Hemicellulose	14.6
i. Pectin (as pectic acid)	1.3
j. Cellulose	3.9
k. Lignin	5.1
l. Crude Fiber	1.8
m. Total acid as citric	1.2

It has been estimated that as much as two hundred grams, or e equivalent of eighteen prunes, added to the usual diet of the der child does not significantly affect either the carbon-dioxide mbining power of the blood plasm or the hydrogen iron con-ntration of the urine. The potential alkalinity of the ash of unes is 24.4.[35]

THE PHYSIOLOGIC EFFECTS OF DRIED FRUITS

Acidosis is a condition usually incident to city life, for in the country and in smaller communities there is no lack of food or play-ground facilities, and malnutrition and acidosis, if present, are simply the aftermath of ignorance of food values. In the city, however, acidosis stands out strongly. Economic considerations enter largely into its causation. Poor food, over-rich food, lack of play-ground space, mental and physical restrictions of one kind or another are only a few of the underlying disturbances of the acid-base balance. Apricots, peaches, and oranges are valuable preventives, but they are, on the whole, expensive, and where pennies have to be counted, their cost is prohibitive. Raisins, on the other hand, are cheap and plentiful and are enjoyed equally by rich and poor. They contain a large excess of basic elements, particularly of potassium in the ash. The true acidity, the hydrogen-iron concentration of the child's urine, affords a valuable means of measuring the "acid" or "alkaline" effects of the ingested ration. Obviously a highly acid urine means either over-consumption of acid-ash foods or under-consumption of alkaline-ash foods. There are, of course, types of acidosis in disease which cannot be here considered. As a result of a number of experiments with raisins, Saywell came to the conclusion that they form a desirable part of any diet, since they have a pronounced basic effect on the body, and that during those seasons of the year and in those regions where fresh fruits and vegetables are not obtainable or when families are impoverished, they furnish a low-priced source of anti-acidotic salts.[38]

DRIED FRUITS IN NUTRITIONAL ANEMIA

To link dried fruits with the cure of disease may seem a wholly irrational procedure. Experience has proven, however, that fruit therapy in disease, for instance in the nutritional forms of anemia, is exceptionally beneficial. Primary anemias are seen infrequently in children, but the secondary variety is very common. While the main etiologic factors in secondary anemia are hemorrhage, acute or chronic, infections, both bacterial and parasitic, malnutrition, and dietary deficiencies, in this work interest centers only on the last two sources. In the secondary form of anemia which develops from them there may be found many fundamental etiologic causes:—

) A lack of iron for the production of hemoglobin
) a deficiency of the so-called anemia-preventing ("A.P.") ctors needed in the formation of the red cells
) a combination of both these agencies
l) a defect in the power of utilization of the iron because of me abnormality in the gastro-intestinal function. The treatent of secondary anemia has been a problem to pediatricians for ars; for if a form of iron is to be prescribed, what form is eferable? Easily assimilable iron found in foodstuffs has seemgly aroused but little attention in the treatment of this disease. nce it has been discovered that liver in some form or other is of eat importance in pernicious anemia, many clinicians have escribed liver in the dietaries of infants and children as an aid combating nutritional anemia.

However, there are some objections to its use. Most of the od-stuffs which make up the nutritional rations of infants and ildren are so well liked that they can be frequently repeated. his is unfortunately not true of liver, for the taste is one of hich the child gets extremely tired. Indeed, such a liver ration ay, in the course of time, produce a marked dislike for it, and me of the liver preparations are often found to be unpalatable d distasteful and many children will refuse liver after a time any form whatsoever.

The administration of iron alone has also physiologic objecons. Given with large amounts of acid, especially in concenated solution, either constipation or diarrhoea, as well as distive disturbances, may arise. The economic situation must so be considered, for iron preparations of worth, even liver ncentrates, are usually expensive. Dried fruits, on the other nd, while containing a large percentage of iron, are not conipating; instead they act as a laxative but not as a cathartic, and ey are moreover so palatable that children eat them with relish. here is contained in liver and in other foods as well some emia-preventing factor, at present unknown, which has the operty of restoring hemoglobin and of motivating the formaon of red blood cells. Whipple believes that raw fruits and getables are effective in this blood regeneration because of a mbination of the inorganic salts, and not necessarily on acunt of the vitamin, iron, or protein content.

Secondary anemias often prove obstinate in children for the ason that the hemoglobin pigment in the child's body may be rgely or completely destroyed. It can readily be appreciated,

therefore, that foods which contain iron, in order to be most effective, should be given over an extended period; and it seems reasonable to believe that in such a case fruits and other substances had best be depended on.[39]

IRON PERCENTAGES IN CERTAIN FRUITS

It may be of advantage to those interested in the prevention and cure of nutritional anemia to compare the iron content of digestible and metabolizable foods. Compare parsley, with an iron percentage of 19.21, with grapefruit, having a percentage of 0.27, dried beans, 9.5 to 11.5 percent; dried apricots, 7.26 percent; raisins, 6.99 percent; spinach, 6.6 percent; dried prunes, from 5-7 percent; fresh peaches, 6.06 percent; leaf lettuce, 1.86 percent; canned tomatoes, from 1 to 3 percent; orange pulp, 0.42 percent; and lastly, orange juice, 0.28 percent. Whipple found that the dried fruits were just as efficient as the fresh, and that dried peaches, apricots, and prunes proved very efficacious in treating secondary anemias.[39]

THE PERCENTAGES OF THE ANEMIA-PREVENTING FACTORS IN VARIOUS FOODS

A list of the results of Whipple's experiments giving the relative quantity of the anemia-preventing factors present in the various foods per one hundred grams, the equivalent of three and one half ounces, is given below [39]:—

Substances	*Percentages*
Beef liver	100
Beef kidneys	90
Chicken gizzard	85
Chicken liver	75
Apricots	40
Peaches	40
Prunes	35
Apples	35
Pancreas	30
Bone Marrow	25
Peas	20
Various types of greens	20
Spinach	14
Raspberries	0
Orange	0
Cereals	practically none

When treating secondary anemias in children, it is obvious that in combining, let us say, chicken liver with apricots, peaches, or prunes, a high potency of the anemia-preventing factor is obtainable. It is also clear to anyone glancing at this list that it is better to combine the fruits with other nutrients in order to gain the desired effects than to give them alone, owing to their greater bulk.

Gray, in seventy-five percent of his cases, which were treated solely by the addition to the diet of one half pound of dried fruit daily, noted a definite approach to normal in the erythrocyte count which preceded a rise in the hemoglobin content of the blood. In ten percent of his cases there was moderate improvement, while in fifteen percent no apparent change was evident. The later result may have been due to some inherited digestive dysfunction, or possibly to faulty metabolism or to some infection. When fruit is given exclusively in the diet without the addition of liver, or some other equally potent food substance, it must be continued over a longer period than if liver and other foodstuff were included. Gray extended his experiments from eight to sixteen weeks, and only after the addition to the ration of one half pound of dried fruit daily, did he obtain his expected results. Quite often in susceptible children a very loose stool follows the eating of a large amount of fruit such as apricots and prunes. When this occurs, smaller amounts should be advised or the fruit stopped altogether.[39]

THE BODY MECHANISM AND INORGANIC MATERIAL

It is not easy to understand fully the body mechanism by which inorganic material so profoundly influences the production of hemoglobin. There is probably within the body a certain give and take of essential amino-acids and other elements suitable either for tissue growth or for repair, as well as for the production of new hemoglobin. It is possible that certain salts and other inorganic elements supplied by vegetables and fruits affect protein metabolism, so that foods which contain them obviously should be added to the protein diet of the child. These elements may in some measure determine the direction of certain building materials within the organism. At one time they may tend to tissue building or repair, at another to the maintenance of body fluid protein. Still at another time they may tend to the formation of new hemoglobin for emergency use as well as to the production of red cells.[40]

FOOD PRESERVATION

As food in its natural state only keeps sound and edible fo comparatively short time, its preservation has long since enga the attention of mankind. Pastoral man preserved milk in form of butter or cheese, and grapes as wine. The hunter so learned to salt, dry, and smoke his animal foods, and later su was added as a preservative. The methods used were pur empirical. Rapid advances in food preservation took place wh the biological causes of decomposition were discovered and app priate methods were employed in preventing it. During the l quarter of the 19th century, brilliant minds gave their attenti to the refrigeration and cold storage of meats and other foods, that they might be protected from harmful agencies and tra ported for long distances.[41]

In undertaking the preservation of perishable food-stuffs, choice must be made between canning, drying, and freezin Canning consists of destroying the organisms present in the foo which produce fermentation and spoilage and of protecting from new contagion by sealing.

Drying removes so much moisture from the product that t living organisms present are unable to grow and multiply, an tends to maintain that condition.[33]

Savages make a practice of drying meats and fish, as well fruits and vegetables, on bushes or on the ground, either in t sun or beside wood fires. Civilized man today salts and smok his meat and fish, and certain kinds of salt-cured fish are dried f market. Nature equips most seed-producing plants such as t cereals with a very efficient dehydrating mechanism by which t seed is protected from spoilage until time for germination an reproduction. In harvesting, man simply collects the ripe gra after it has become sufficiently dry to handle for use. Similar the legumes when matured are dry seeds, naturally dried, and a protected from both animal and insect pests. The nuts are pr tected by a natural covering. Most nuts when gathered are mo and, unless dried within a reasonably short time, are liable to invaded by microorganisms. They also become rancid. T cocoanut is an exception, for its interior is partly filled wi cocoanut milk and the shell must be removed before the conten can be dehydrated artificially. Dehydrated vegetables and fru are more easily carried in bulk on long journeys than the fre products, as they may be packed more compactly. The produ slightly altered by canning and drying may differ impercepti

from the fresh material in appearance and flavor but retains its full nutrient content. Quick freezing at very low temperatures maintains the food in its original condition and in such a state that no bacteria or other destructive agents can destroy it.[33]

DRYING

It is of great importance to choose the best method for preserving particular foods, as they differ in the kind and degree of moisture and temperature necessary to retain their proteins, fats, carbohydrates, salts, and vitamins. The antiscorbutic vitamin in particular is delicate and much care should be exercised in choosing the proper method for its preservation. At the present time, apparently, there is not an extensive use of dried vegetables as antiscorbutic agents. Nor is there very much conclusive and scientific evidence which guarantees for the dried product those properties present in the raw. It would seem indeed that much of the evidence has been rather of a negative character. Holst, Froelich, Chick, and Hume found that dried vegetables were more or less deficient in antiscorbutic properties. Recently, Chick, Hume, and Skelton have reported that the feeble antiscorbutic qualities of fresh milk were destroyed either by drying or by long storage after drying. Hess and Unger have stated that "dehydrated vegetables" were found to contain few or no antiscorbutic qualities. Steffansson alleges that, while antiscorbutic properties are present in fresh foods, he has found them to be diminished or to disappear after preservation and storage by any of the common methods in use—canning, pickling, drying, etc. Experience demonstrates that the lowly Irish potato when baked is very efficient as an antiscorbutic, and that raw fresh tomatoes dried in a blast of air at either a low temperature of 35-40° C. or a high temperature of 55-60° C. retain a significant supply of their antiscurvy potencies. The antiscorbutic vitamin which is contained in many foods may be destroyed by drying, but to what extent is apparently unknown in many instances.[42]

Givens, McClugage, and Van Horne believe that, at least in the case of the raw apple and banana, subjection to any considerable temperature such as is ordinarily employed to desiccate foods does reduce or inhibit the activity of the antiscorbutic vitamin. Chick, Carter, Howe, and Mason, state that dehydrating apples at from 35-40° C. is more destructive of the antiscorbutic vitamin than is desiccation at from 55-60° C. The cellulose covering of the apple may act as a protective agent against the

destructive influence of the amount of heat needed in the dehydration. It has been found that dried apple peelings proved excellent vitamin protectors, which might imply that the cells under the skin contained more of the vitamin than the body of the apple.[5] Eckman made a series of experiments on a group of guinea pigs, using a ration consisting of alfalfa meal and white wheat flour plus one percent of sodium chloride; to which was added dried peaches, apricots, apples, pears, prunes, cherries, and loganberries, precautions being taken to insure a uniform quality of these products. Water and the alfalfa flour mixture was fed to the animals ad libitum. When scurvy symptoms developed they were accompanied by a great loss of weight. Then the amount of fruit in the ration was increased, but the animals either refused the food or else ate but little of it, the dried loganberries and the cherries being especially obnoxious to them. However, those animals which ate the dried peaches, apricots, and apples showed a greater resistance to scurvy than did those which ate the other fruits. The only animal of the group which definitely survived beyond the average accepted life term, subsisting on this scurvy diet alone, was the one which ate the peaches. It seems to us that the possibility of an inherited resistance to the disease should be also considered. In this experiment the only dried fruit which apparently contained enough of the anti-scurvy vitamin to maintain life was the peach, but good results were secured also from the eating of apricots and apples. The pears, prunes, loganberries, and cherries were apparently of minor importance.[43]

Fruits like figs, dates, and raisins, whose nutrients have been concentrated by evaporation, naturally contain much greater proportions of natural sugar than do the fresh fruits; indeed, frequently fifty percent of fructose may be present; while jams, syrups, jellies, and similar products almost always contain added sugar. Dextrose is less sweet than cane sugar, and levulose is much sweeter than dextrose. Both these sugars are usually found together in the fruits. Dextrose occupies an important place in the raisin and in other dried fruits. More sugar is required to sweeten acid fruits before they are cooked than afterward. This may be ascribed to the change of the cane sugar into invert sugar, or to whatever sugar into which it is changed under the influence of the acid and heat.[3]

There is one marked characteristic which dried foods possess over the fresh variety; namely, their better preservation. In this respect also they approach nearer to the natural foods than do those which are canned. Since the presence of large amounts of

ater in foods greatly increases their probability of spoiling, it ollows that the removal of excessive amounts of this fluid from ne foods will lessen the danger. However, the water must be so emoved that the food value of the fruit will remain at its highest evel. Dried foods are, in fact, nearly equal in food value to the esh foods, but they lack their piquancy, flavor, and tang. While nan, as has been said, has desiccated much of his food for cenuries by natural means, it has remained for science to do it for im much more efficiently. The newer methods of desiccating ggs, for instance, have broadened the field of their usefulness, or they may withstand transportation and long preservation. ggs when dried are apparently more stable even than dehydrated ilk. Since the beginning of the twentieth century, enormous gg-drying plants have been established in China and a dried gg product suitable for transportation is made from sound, ood eggs.[32] The addition of water to dehydrated foods usually eturns them nearly to their original state. Even in the home oday, desiccated foods form the basis of many desserts and table elicacies. If the process of dehydration is carried out properly nd scientifically, the danger from infection, from flies, worms, nd microorganisms is markedly minimized; dangers from which atural desiccation is never free. Sometimes, even under the best upervision, molds may grow on foods which are but slightly noist, and both bacteria and yeast vary much with respect to the mount of water which is required for their development. While nzyme action may be arrested by dehydration, yet if desiccation carried on at low temperatures rather than at high, these nzymes which have remained dormant will become revivified hrough a renewal of the water which was abstracted in the rying. Dehydration may, however, result in marked colloidal hanges in the structure of most of the foods. It is true that the atural cell structure of foods may be changed, and it is possible hat these cells do not fully return to their original state; yet the dvantages of desiccation are undeniably greater than are the isadvantages.[32]

CANNING

Canning is an effective method of using heat and air-tight ontainers to preserve foods as nearly as possible in their original tate. It is an economical method of preserving substances so hat their use may be distributed in many places and covering nany seasons when fresh articles are not procurable.[44]

The method of canning may affect the vitamin content of the

food to some extent. With the possible exception of vitamin C, which is destroyed if heated in the presence of free air, there is no serious loss of vitamins except when the contents are removed from the cans and reheated for use. Packing foods when hot and processing them in their containers tend to maintain the vitamins. None of the minerals are lost in canning, provided the liquid in which they are cooked fills the containers and that the entire contents of the can can be served at once. Fresh fruits, vegetables, and meats contain enzymes which under normal conditions cause the fruit to ripen naturally and meats to become tender when stored. These enzymes, however, if unchecked hasten decay. Very low temperatures of cold storage retard, and high heat in canning may destroy them entirely. To prevent destruction or deterioration, substances should be preserved by canning or freezing soon after they are gathered.[44]

Practically the only organisms causing unsoundness in canned fruits are the yeasts, molds, and bacteria, such as coccoid bacilli, gas producing, non-spore-bearing bacilli, and the micrococci. None of these, with the doubtful exception of yeast, produces spores. All are, therefore, evidently readily destroyed by heat because it is the spore and not the vegetative form of the micro-organisms which is heat-resistant.

Yeasts, molds, and bacteria are present on foodstuffs in soil, air and water. They are killed at high temperatures (150-180° F.) by canning and held in check in sterile, air-tight containers, but when not so checked they produce a rapid decomposition.[44]

When peeling or slicing fruits and vegetables for canning, a number of changes take place from molds, yeasts, and bacteria which should be checked if such foods are to retain their natural qualities. A darkening or discoloration may take place, the pigments are broken down, and the flavoring substances affected. There is a partial destruction of the sugars and proteins, with the production of new and undesirable odors and flavors. The decomposition, which takes place after the outer covering of foods is removed, can be arrested by raising the temperature to 175-185° F, but such heat might cause injury to the product. The rapid heating of fruits and vegetables in dry air at these temperatures tends to burst the cell membranes and permits the escape of water, which carries with it dissolved sugars, inorganic salts, and flavoring substances. The best temperature is one which will not affect the food substance. This is determined by the physical structure, chemical composition, and water content of the particular food.[33]

A very high temperature may produce a sterile product at

at sacrifice of flavor and texture. Most varieties of bacteria are troyed at a temperature of 212° F, but spores are usually heat istant. The rate at which bacteria are killed differs in acid and ali foods. When foods are distinctly acid, as are most fruits l tomatoes, all forms of bacteria are killed at the temperature boiling water (212° F). In non-acid foods, such as meats, corn, as, beans, and practically all vegetables, bacteria are destroyed ly at high temperatures (240-250° F), which is only obtainable a steam pressure canner.

The types of bacteria vary with different foods, the year, the ality, and the conditions of production, and they produce ferent types of spoilage. Spinach growing low in soil may rbor soil bacteria, as does the fuzzy coating of string beans.[44]

Fermentation, acid, and gas are formed by the action of bacia, causing the food to become sour and cheesy. Bacteria using flat-sour spoilage produce acid without gas. Corn, peas, l string beans are subject to this type of spoilage.

The growth of putrefactive bacteria in canned food is marked gas production, a bad odor, a softening and darkening of the od; and occurs usually in substances of low acidity such as peas, ats, and corn. One notable exception is the bacillus botulinus, often fatal form of food poisoning. The fear of poisoning by tulinus, a spore-producing organism, is however in many cases founded.[44]

Botulinus spoilage is caused by the spores of botulinus bacteria oducing a toxin in the food contents. They will not grow in nned foods in a more than 9 percent salt solution, or if the ntents are sufficiently acid they are killed at a temperature of 2° F.[44]

Even though botulism is set up entirely by the action of the ghly poisonous toxin produced by the bacillus, both experintal and epidemiologic evidence suggest that the spores alone n be consumed in considerable numbers without danger. In t, these spores do not develop and produce toxins in the imal body. It is a notable fact that, with the one exception of outbreak of botulism from olives in Canada and in the United ates, according to our research, no other incidence of this eaded disease from canned fruit has been discovered.[29]

Modern science has performed wonders in the preservation of odstuffs, in that the nutrients are held in their original state and e elusive vitamins are not destroyed. Let it be said that no elligent mother employs a physician of whose ability she is norant, nor does she serve canned products—vegetables, fruits, syrups—without first ascertaining the standing of a particular

food-products organization and the scientific procedures used i the processing of their foods. A food processing concern is lik an individual, good or bad, modest or blatant, honest or di honest; all of which qualities depend on similar qualities in th officials of the company.

Earlier methods of food preservation by canning in the hom have in many instances given way to modern improvements. Th proper canning of foods has always been largely a question o air-tight sealing. The sight of boiling, sizzling pots full of frui on the stove, their contents emitting a delightful, pungent odo and the rows of filled fruit jars in the cupboard are sights whic are, however, sadly missed. In contrast to present day hermet sealing, metal caps jammed on rubber washers were formerly con sidered adequate protection, but a certain number of jars we undeniably spoiled by improper sealing, thus admitting micro organisms. However, if a bottle or other open container is fille with any food product and loosely stoppered with absorben cotton, then thoroughly sterilized, the contents will remain pur and sweet indefinitely, although air is free at all times to circula through the cotton. Thus sheltered, the food will remain pre served against contamination by microorganisms through th filtering action of the cotton. Any microorganism or enzym activity in the contained food is previously killed by heat. Th hermetically sealed containers in which all commercially sterilize foods are packed are absolute proof against the entrance of bot animal and insect pests and their eggs. The effects also of evapo ration, humidity, light, and both physical and chemical spoilag are halted by this processing method.[32]

Tin plate from which cans are made consists of a sheet of pur iron coated with a thin layer of pure tin. The amount of ti varies according to the nature of the products packed. The m jority of fruits and vegetables are packed in cans made from pla carrying something like 1.5 percent of tin. The actual percer depends not only on the thickness of the tin coating but also o the thickness of the iron or steel, which of course is greater large cans, such as the No. 10s used in the hotel trade, than the smaller sizes of cans.[45]

Unfortunately, the manufacturer has often one particul worry; namely, the action of the contained food product on t walls of the container. With glass and aluminum lined vess this action is not serious, but with tin containers dangerous to action formerly arose. Indeed, it may be said that all cann goods show at least some, often very faint, chemical action fr the tin plate of which some cans are made.

The most serious effects of this chemical activity may be seen n the corrosion of the can with a resultant solution of tin and ron in the food. This process may lead to an actual perforation f the can or at least to a distinct blackening of its interior; which nay at times be transferred to the food contents. While corrosion f the can may occur with many foods, it is serious only when the ontents are very acid or, paradoxically, as shown with certain egetables, when nearly neutral in action; squash and asparagus re instances. This acid action which corrodes the tin container lso tends to bleach highly colored fruits, berries, and vegetables. Iowever, of late, an especially prepared enameled tin container s being tried which may offset any destruction of the contents. Canned apples, cherries, and berries are generally the principal ffenders when cans are found to be perforated on account of orrosion and the development of hydrogen gas. Before serving hem they had best be tested for spoilage.

The cause undoubtedly is some obscure chemical combination. The blackening of the interior of the can is principally the result f hydrogen sulphide gas found in high protein foods and in some egetables, but in other foods it is due to oxygen. Hydrogen ulphide may cause destruction of canned meats, fish, and corn. These reactions fortunately proceed very slowly and many canned oods are eaten before they take place. Modern scientific methods nsure against contamination and retain the nutrients intact, vith the questionable exception of the vitamins.

Most vegetables are practically neutral in reaction and are, herefore, susceptible to spoilage by virulent heat-resisting forms f bacteria. Asparagus, corn, peas, string beans, spinach, mushooms, and other vegetables are usually sterilized in closed steam etorts at temperatures of from 230° to 250° Fahrenheit for from wenty minutes to three hours, depending on the size of the can nd on the ease with which heat can penetrate the center.

The canning of fruits has become a major industry and during ny part of the year these products may be served with safety. Except perhaps in poverty-stricken homes in the country, fresh egetables and fruits may be stored away for winter use. In the arge cities these foods may be procured fresh during the whole ear. Fruits are different from vegetables in that they are sufficiently acid in reaction to minimize or to prevent the development of heat-resisting bacteria; they need, therefore, but very mild processing as compared with vegetables.[32]

Alexander Brice speaks strongly against the cooking of fruits, as he believes it tends to create a more marked acidity, making the fruit less digestible than when eaten in the raw state. Possibly,

as he asserts, the enzymes in the form of the oxidases and diastases, from which the child derives nourishment, may be destroyed in the process of cooking. This increase in acidity might suggest that some volatile alkaline ingredient may have been driven off by the heat which, had it remained, would have served to neutralize the harmful acid ingredients of the fruit or would have rendered them at least more tolerant to the body juices. It may be, too, that through the heating some valuable and natural chemical salt is decomposed and that in this manner the child's body is being robbed of some essential nutrient.[1]

Davis, on the other hand, believes that cooking makes fruit more digestible, as it softens the cellulose and converts the gum (pectin) into a gelatinous mass. He does admit, however, that if fruit be cooked in water, a part of its nutrients are lost in the surrounding medium.[3]

Tomatoes, while usually included among the vegetables, may be designated as a fruit when canned. Ripe olives are similar to vegetables and must be well heated, both to remove the danger of spoilage and to kill the poisonous botulinus bacillus. Peaches, plums, pineapples, and apricots are comparatively easy to safeguard, and they corrode the can but little and seldom perforate it by their chemical action. These canned fruits may, in consequence, be safely given to children.

With certain canned meats, fish, and shell fish, there has long existed, more or less, the fear of poisoning. Deviled ham, potted tongue, veal loaf, and other animal protein foods may be prescribed with impunity if salt cured, heat-treated carefully and thoroughly, and refrigerated under modern scientific methods. This freedom from danger also includes fish, salmon, sardines, tuna fish, lobster, shrimp, crabs, oysters, and clams. The contents of the containers should be removed at once and placed in glass vessels. As these latter foodstuffs may infrequently give off hydrogen sulphide in the can and thereby cause a blackening of it, paper lined cans have lately been substituted by several food-products organizations for the tin variety.[32]

MICROBIOLOGY OF FROZEN FOODS

The preservation of foods by freezing may or may not be an advantage. It depends on whether they are frozen quickly or slowly. Wallace and Park undertook a series of investigations as to whether or not botulism could occur from frozen foods. With proper quick freezing methods, they found that the fear of this organism should not be unduly stressed, as the low temperature

the food in storage would prevent its development. The
nmediate freezing of foodstuffs at low temperatures is impera-
ve, but cans have been known to stand for as long as twenty-four
ours before their contents have been subjected to freezing.

Canned frozen foods should not be allowed to stand at room
mperature for any length of time after defrosting. Under these
rcumstances, the toxins of Cl botulinum for instance might
ossibly be developed and subsequently cause an outbreak of food
oisoning. However, after extensive and exhaustive tests, investi-
tors came to the conclusion that if foods are canned properly
nd served immediately after defrosting there is little danger
om food poisoning, for while the toxin of this organism is not
adily destroyed by freezing, there is little danger of it being
esent in rapidly frozen foods. Undeniably, however, the spores
Cl botulinum are resistant to freezing, and once present in
e frozen foods they are hard to overcome.[46]

The development of refrigeration lagged until 1890, when dur-
g a mild winter the large food packers acquired sufficient
atural ice to protect their products, or else they installed
echanical refrigeration. Since then refrigeration has progressed
slow degrees. The newest industrial application of freezing
ods, which is a decided forward step, is by quick freezing
ethod, which is food preservation at its best. Quick freezing is
advancement in the art of applying low temperatures, as the
inciple of conduction rather than of convection methods used
eretofore. It is a direct communication of cold from the freezing
opliances with which the food comes in contact. Earlier freezing
easures transferred cold by means of currents in liquids or
ses which resulted from changes in temperature. A well
cognized law of chemistry states that when solutions are allowed
crystallize the size of the crystals is in proportion to the time
lowed for them to form. The longer the time the larger the
ystals. Animal tissues are made up of minute cells filled with a
mi-liquid protein gel. This substance contains water in which
e dissolved the salts of sodium, calcium, potassium, and mag-
esium. This water does not freeze uniformly when the product
slowly frozen. Instead fresh water begins to form or crystallize
it of the cellular and inter-cellular tissues when the temperature
lowered to about 31 degrees Fahrenheit.[47] As the temperature
further decreased, more and more water crystallizes as ice,
aving more concentrated solutions of the various salts.

In the case of slowly frozen flesh substances, such as meat, fish,
nd poultry, the crystals may grow to many times the size of the
ndividual cells. These crystals tend to injure the tissues and

tear and destroy the delicate cell walls and on defrosting cause excessive leakage, which results in loss of flavor and changes the characteristics of the product. Animal and plant cells do not freeze or defrost in the same manner, for the former are elastic and the latter inelastic. When fruits and vegetables are slowly frozen there is a complete precipitation of the colloids, which causes a separation of the solids and liquids. When these substances are subsequently defrosted a leakage takes place and their flavors are dry or otherwise unnatural. When fruits and vegetables are quickly frozen coagulation takes place, the semi-liquid hardens, and their original flavors and appearance are retained. It is obvious that what time and what temperature must be known, to obtain the greatest number of small crystals in the shortest possible time.

There are four primary methods of quick freezing.

First, direct freezing by immersion. The substance to be frozen is dipped in a sodium chloride brine which freezes around 5-7 degrees below zero (Fahrenheit).
Second, indirect immersion or spraying. The materials to be frozen are placed in a can and either sprayed or immersed in a salt brine which freezes at about minus 54 degrees (Fahrenheit).
Third, the simple plate method. The material to be frozen is placed on a metal plate, the underside of which comes in contact with the brine.
Fourth, the two-metal surface method, in which the substances are placed between two metal surfaces and then subjected to pressure.[47]

Dr. Carel R. Fellers has shown that peas quickly frozen immediately after taken from the vines preserved their vitamin C content to a greater extent than that found in fresh peas exposed for days in the market. Spinach and whole kernel corn, however, suffered no loss of vitamin A and retained a full content of vitamin C. Asparagus and strawberries were tested after immediate freezing and were found to have a maximum vitamin C content.

Obviously quick freezing neither improves nor impairs foods, but does preserve the quality of the food present. With many methods of freezing, foods are left in a frozen state in storage and the quality of their nutrients deteriorates.

The agencies which cause foods to deteriorate are desiccation, oxidation, and autolysis. Desiccation is the gradual evaporation of moisture from animal products, even at low temperature. Oxidation is produced by the combination of oxygen with natural

ts or oils, which either destroys or lowers nutrient values. utolysis, or self-digestion, is produced by enzymes which comonly appear in the ripening of meat.[47]

OODS FOR MAINTAINING THE ACID-BASE BALANCE

The study of foods in their relation to the maintenance of id-base balance in childhood is of great biologic importance. his delicate organic adjustment is a powerful incentive to ealth and longevity and probably to fecundity. In later life, hen minor dysfunctions and disease potentialities have grown major ones with the maturing of the organs and tissues, organic sease may often be recognized as developed from seeds planted infancy in hospitable soil.

To the average layman, a discussion of the foods necessary to lance the acid-alkali mechanism is often meaningless and ould be explained in simple terms. Paradoxically, notwithanding the huge quantities of acids produced in metabolism, the action of the blood normally remains remarkably constant and ghtly alkaline, probably between pH7.35 and pH7.43, and a eparture from the limits pH7.32 to 7.47 is hardly compatible ith the child's health, except perhaps for very short periods and ter strenuous exercise which causes deep breathing, and pH7.0 pH7.8 are considered the extreme range compatible with life. he normal fluctuations of fixed acid production in healthy ildren depends upon the diet which, taking environmental ctors into consideration, cannot be too wisely chosen. Foods ry widely as potential sources of acid or of base principles in etabolism.

The careful clinician consequently directs his attention to rtain foods in the maintenance of acid-base balance. Meats, sh, and eggs contain a preponderance of acid-forming elements. the case of fish, however, the inorganic salts contained, iodine particular, apparently affect the acid-forming principles of the her two foods. Fruits, vegetables, and milk, on the other hand, ow a maximum of base-forming essentials. If, in the child's et, the proportions of fat, carbohydrate, and protein are so arkedly in disproportion as to upset the ketogenic ratio, the ody may be flooded with organic acids of incomplete fat comustion, which may in rare cases induce acidosis. It is unnecessary add, therefore, that the proportions of these nutrients, should thoughtfully considered for each child. Clinical experience ould seem to indicate that base-forming foods aid in lowering e comparatively high blood pressure of nervous, energetic

children. Many of these little patients show a highly acid urine.

Blood chemistry is a valuable aid in scientific nutrition, for many inherited states and disease diatheses show signs which favor either the acid or alkaline side of the body base. Consequently, through blood chemistry one may find the roots of many conditions which eventually become acute or chronic diseases. An excess of meat and eggs in the diet of the average child not only gives rise to urinary acidity and urinary ammonia, but these foods decrease the uric acid solvent power and show, by a lowered carbon-dioxide tension of the alveolar air, a tendency toward a depletion of the reserve alkalinity of the blood.

While the breadstuffs and cereals show a slight potential acidity, milk and cream, on the other hand, possess a slight potential alkalinity. The mineral content of commercial fats, sugars, and starches is too low for them to have any significant effect upon the child's acid-base balance. Many fruits and fruit juices contain the acid salts of organic acids, such as the potassium tartrate of the grape, most of them being di- or tribasic in character, and existing in the fruit or fruit juice partly free and partly as acid salts. The citrus fruits contain free citric acid as well as acid-potassium citrate. Obviously these foods when eaten raw have an acid reaction, due to their organic acid radicles, which usually are burned in the body with the formation of carbonic acid and potassium bicarbonate. There arises the question, however, as to the completeness with which the organic radicles are thus burned in metabolism, a process which is quite probably

TABLE 1

FOODS IN WHICH ACID–FORMING ELEMENTS PREDOMINATE

Food (Edible Portion)	Approximate Potential Acidity (cc. Normal Acid)	
	Per 100 Grams	Per 100 Calories
Beef, clear, lean	12	10
Round steak	11	7
Eggs	11	7
Oysters	15	30
Oatmeal	12	3
Rice	9	2–6
Wheat, entire	12	3–3
Wheat flour	9	2–7
White bread made with water	6	2–5

fluenced both by the kind and amount of food consumed by the
hild. Consider in this respect cranberries, plums, and prunes,
hich give rise to hippuric acid and remain unoxidized, so that
ese fruits increase rather than decrease the acidity of the urine.
On the other hand, fresh orange juice may be taken by the
erage child in large quantities without in the least interfering

TABLE 11[48]

FOODS IN WHICH BASE-FORMING ELEMENTS PREDOMINATE

Food (Edible Portion)	Approximate Potential Reserve Alkalinity (cc. Normal Alkali)	
	Per 100 Grams	Per 100 Calories
pples	3.7	6.0
sparagus	0.8	3.6
nanas	5.6	5.6
ans, dried	18.0	5.0
ans, lima, dried	41.0	12.0
ans, fresh	14.0	12.0
ans, string	5.4	13.0
ets, fresh	10.9	23.6
bbage	6.0	18.0
nteloupe	7.5	18.8
rrots	10.8	23.9
uliflower	5.3	17.5
lery	7.8	42.0
ard	15.8	41.0
tron	9.8	3.0
cumbers, fresh	7.9	45.0
ates	11.0	3.2
mons	5.0	12.0
mon juice	4.0	10.0
ttuce	7.4	38.7
ushrooms	4.0	9.0
lives	45.0	18.0
nions	1.5	3.1
ranges	5.6	10.9
range juice	4.5	14.3
rsnips	12.0	18.0
as, fresh	1.3	1.3
as, dried	5.0	12.2
ars, fresh	3.6	5.6
tatoes	7.0	8.6
tatoes, sweet	6.7	5.4
mpkins	1.5	5.7
omatoes	5.6	24.5
urnips	2.7	8.9
atermelon	2.7	8.9

with the ability of the body to oxidize the citric acid radicles. The tolerance of the child's body for different organic acid radicles seems to be strongly individualistic, but what becomes of the oxalic acid and of the oxalates in the body we do not know. Tables 1 and 2 list foods containing predominating acid-forming and base-forming elements respectively.

FOODS OF THE FOREIGN-BORN

The study of scientific nutrition in infancy and childhood is never completed. Scientists are ever expounding new theories, developing new vitamins, or finding hitherto undiscovered nutrients. Cooks are constantly creating new food combinations, some far too rich and elaborate for children and fit only for the epicure. others simple, easily digestible, tasty, appetizing, and attractive. Many races and peoples have in the past elaborated dishes which have come down to posterity and still hold a worthy position in the dietary. Aliens, and often their descendants, cannot readily conform to the customs and food habits of those outside their own exclusive circles. Consequently, the food problems of the clinician in these alien communities are perplexing and often discouraging, and he, possibly brought up in ignorance of foreign customs, is inclined to consider those outside his own group as impractical and often barbaric. If, however, he desires to achieve success in his nutritional work, he must have a sympathetic understanding of these different customs. To better understand these people it is well to conduct clinics among them, or at least to visit the restaurants which they patronize, and to become accustomed to the foods which they enjoy.

Since we enjoy such foreign foods ourselves, we recommend them wholeheartedly to others. We have often found it wise in our practice to modify our own ideas somewhat, according to the religious customs, habits, and traditions of even the lowliest immigrants. Their psychologic reactions to modern methods must be considered, and they should be won over gradually by clear, simple, and understandable explanations. The intelligent foreign groups, however, usually conform readily to the customs, habits, and traditions of those people among whom they find themselves.

The first impressions of the immigrant after landing in any strange country are usually gained in a poor neighborhood, settled by those of their own race and country, where they follow the customs, habits, and cookery to which they were accustomed in the homeland. These people find it hard to break away from the

d methods and adopt modern innovations. Often even the ucated and better class of immigrants, regardless of a different mate and a different occupation, make no changes in their etary habits. They eat the same foods and they prepare them the same manner as did their ancestors. Care should be taken t to offend their racial and religious dietary laws, or to poke fun ancient hygienic methods which these people have been ought up to observe and respect. Indeed, we might as well ticize ourselves, for we are still in many instances following tiquated dietary customs and food habits, methods of cookery, d prescribed rock-bound periods for meals.

Even the foods suitable for children are often given in onotonous, unvaried regularity, and strong healthy youngsters e sometimes prone to break away and develop a dietetic anderlust." The addition to the diet of unusual foods affords ildren a wider choice and adds to their dietary common trients in a new setting. It may therefore be of interest to ke a rather generalized food journey and to pay a visit to some reign peoples. It is to be hoped that the foods chosen may d a favorable reception and that we may not be accused of an dividual taste in selecting them as purely typical of these untries. As background, regional conditions and native life e also shown briefly.

A FOOD JOURNEY

MEXICO

The starting point of our journey is Mexico. The people of e poorer class, both in the cities and in the sparsely settled mmunities, live in crowded and unsanitary conditions. The uses are small, unhygienic, and often without water. In the tlying districts the homes are well ventilated, for the windows d doors are always open. The people eat and sleep indoors but end the rest of the time outdoors. The infant mortality is high, r while the infant is breast fed, the mother lives on unsuitable ods and in most unfavorable surroundings. After the first few onths of breast-feeding, the infant is suddenly switched to too avy foods, such as frijoles or beans, cantaloupe and water- elon, which increases the mortality rate, particularly during the mmer months. If the children survive, they are given beside ans and fruit, rice, potatoes, peas—indeed, all kinds of veg- ables, and a great quantity of chili and pepper. However, a stew hich contains a small amount of meat and many kinds of veg- ables, all well cooked, proves a very tasty meal for older chil-

dren. On the whole, there is too much starch and too little animal protein, as well as too few inorganic salts in their foods. The same diet is given to the nursing mother. Mexican foods are too highly spiced and the diet contains a large quantity of fat; cornmeal, for instance, is fried in fat. The better classes provide an inviting menu, consisting of chicken, chicken soup with rice, vegetables, fruits, cereals (mostly rice and oatmeal), milk, and eggs. The dish described below is both attractive and wholesome and may advantageously be added to the food regimen of other peoples.

STUFFED PEPPERS

6 green peppers

1 tin sardines

1 cup fresh bread crumbs

1 tablespoon grated cheese

½ cup tomato sauce

Cut the peppers in half lengthwise. Remove the stems and seeds and wash well. Pour boiling water over the peppers, and let stand until cold. Bone sardines and mash to a pulp. Add the bread crumbs and cheese and mix well. Moisten the mixture with the tomato sauce and season with salt. Fill the halves of the peppers with the mixture. Place in a greased baking dish and pour tomato sauce or soup over them. Bake in a moderate oven until peppers are tender.

PORTUGAL

Crossing the Atlantic Ocean to Portugal, we find spotlessly clean, artistic houses, and in the sanitary surroundings we forget the uncleanly habits of the peon in Mexico. Fishing and gardening are the chief pursuits. The food comprises fruits, vegetables, cereals, eggs, and soups. We have selected the following dish as one suitable for children.

BOILED FISH

4-5 lbs. haddock or cod fish
2 tablespoons vinegar
2 teaspoons salt
1 green pepper or clove garlic
2 tomatoes
4 cloves

Clean the fish thoroughly. Place it in a pot and cover it with a little salt, vinegar, spices, and the tomatoes. Then add two cups of water. Simmer until the fish is cooked.

ITALY

We continue our journey to Italy, where we visit first the uthern portion of the country. Here we find the peasants living starchy foods, such as wheat, corn, etc., eating vegetables, uits, and chicken only occasionally. In their homes they drink lk from sheep and goats, away from home and on journeys rs' milk. They make cheese from goats' milk, which has a aracteristic odor and flavor, the taste for which a foreigner ould cultivate. Dried peppers, garlic, and tomato paste are red away for later use. Olives, either eaten alone or cooked th corn or macaroni, are appetizing dishes judged by any ndards. Here, too, we find fish eaten largely for its animal otein, and snails, taking to some extent the place of oysters, e often combined with rice and macaroni. Foods in southern ly are more highly seasoned than in the central and northern rtions and we therefore hesitate to suggest any particular dishes. winter the supply of food is limited, the diet unbalanced and king in nutritional qualities, for the methods of preserving it e crude and very unsatisfactory. The food consists largely of nato paste, pickled peppers, cucumbers, and olives, while milk missing from the dietary. The price of food in other countries en being unnecessarily high, the Italian immigrants tend to too many starches, such as bread, macaroni, and potatoes. It no uncommon sight for the pediatrician to see very young ldren fed on foods fit only for adults and to note the high rcentage of rickets found among them. Indeed, in many homes ge quantities of the carbohydrates are eaten, but often too few getables and fruits. Bread and sausage foods washed down h tea or black coffee often comprise the meal. Central Italy nbines the foods and also the cooking customs of both the uth and the north.

Italy, therefore, may be said to be divided into three distinct tions, all individual in dialect, in foods, and in eating habits. ssing to the north, we discover goats' milk for children, wheat ead with butter for breakfast, a food which appears dark and refined from being baked at the bottom of the oven rather n in tins. It may be baked also on stones or in open fireplaces. night, among the poorer classes, a black pot is hung over the e and into it is thrown a little meat and perhaps some beans, getables, macaroni, lard, or olive oil, and at times an egg or o. Polenta alla Parmigrans, however, may be chosen as a tritious dish for children.

POLENTA ALLA PARMIGRANS

1 pound Indian corn flour

Parmesan cheese

melted butter

Stir the Indian corn flour, a little at a time, into a pint of boiling salted water until it is absolutely smooth. Then turn into a dish to cool, in a layer about one half inch thick. When quite cold, cut the mixture, which by this time has become solid, into pieces about one inch long, and arrange them in layers in a baking dish, sprinkling each layer well with Parmesan cheese and some melted butter. Bake in a slow oven and serve while fairly warm.[49]

Northern Italy provides excellent and nutritious dishes for older children and adults, which may well be included in the dietaries of other peoples. Examples are:—

LENTIL SOUP

3 tablespoons dried lentils

½ tablespoon butter

2 tablespoons milk

4 cups soup stock

Cover lentils with water and simmer until they are soft, then strain. Melt the butter in a saucepan and add lentils and milk. Mix well. Add the cup of stock and then add the entire resultant mixture to three cups of hot soup stock.

GNOCCHI OF MILK

1 cup milk
1 tablespoon cornstarch
3 drops vanilla
2 egg yolks
2 tablespoons sugar

Put all of the ingredients together in a saucepan. Mix well. Then place on the stove and cook it slowly until thick. Remove from stove. When cold serve with milk or cream.

ZABIONE

cups milk
cup sugar
drops vanilla
tablespoons fruit juice
eggs

Put all the ingredients together in a saucepan and beat them well. Place on stove and cook it over a low flame, slowly. Stir often until it is thick. Serve it hot or cold.

GNOCCHI ALLA ROMANA (farina or corn meal)

cup farina or corn meal
gg
ter and grated cheese
oint of milk or half milk
nd half water

Let the milk come to boil, salt it, and add the cereal gradually. Stir constantly. Do not allow it to become lumpy. Remove from the fire and add one tablespoon butter and three or four tablespoons grated cheese. Then beat one egg slightly and add. Mix it all well, and spread out on a molding board in a sheet about three quarters of an inch thick. When cold, cut in diamond shapes or in squares. Put a layer of these in a shallow baking dish or platter that has been buttered. Sprinkle with the cheese and butter. Make another layer, etc., until the dish is filled. Bake in oven until crust is well browned.

HUNGARY

eaving Italy by plane, we travel northeast over the rugged intainous regions of Albania and Jugo-Slavia, and arrive at a n little Hungarian village, about one hundred miles south Budapest. Hungrily, we make a meal of coarse bread, bacon, ogna sausage, with sour or curdled milk as additional nutri-. Wheat is the principal cereal used, and noodles a favorite made from it. Passing northward, we later dine in Budapest, an open midtown sidewalk restaurant near the National atre, a place of histrionic memories, ordering a distinctly Hunan dish, paprika of fish, while our pilot prefers one made of ken. Both dishes, however, have already travelled to other s of the world.

PAPRIKA OF FISH

½ pound raw fish
2 cups potatoes, diced
2 tablespoons chopped onion
1½ cups water
2 teaspoons chopped parsley
2 tablespoons oil
½ teaspoon paprika
½ teaspoon salt

Brown the onion in the oil. Ad the potatoes and brown. Ad fish which has been boned an cut into small squares. Mi these together thoroughly. The add the parsley, the other seaso ing, and the water, and cook fo twenty minutes. Serve wit sliced lemon.[50]

POLAND

Speeding northward to Poland and to the neighboring Sla states, we find many farms deserted, or short-handed, larg numbers of their occupants having emigrated. The food produc of these different countries are grains, vegetables, and legume Indeed, there seems to be a plentiful supply of beans, carrot turnips, parsnips, cabbage, and lettuce, with milk and meat i large quantities. There is apparently an abundance of bee veal, pork, and the ever present sausage. Fish and meat a frequently made into puddings; and the former can be we recommended. Solely primitive methods are used in the prese vation of foods; fish and potatoes being pickled. Apparentl game is the only fresh meat obtainable during the winter month Barley, corn meal, and oats are the cereals universally favore while among the wealthier classes, eggs, chicken, and duck, wi flax seed oil as a fat addition, provide a welcome diversion.

The country children appear better nourished than those the cities, living largely on milk and other energizing foods, wh the latter often eat the food given to them from the parents' tab Three dishes of these Slavonic peoples have proven appetizi

KISSELLE

1 quart raspberries or grapes
sugar
2-3 tablespoons cornstarch
cream

Wash the berries or grapes w and drain. Cover with c water and cook until soft. Str this mixture through che cloth. Add enough sugar to s taste and place on stove to co When it reaches a boil, add t or three heaping tablespoons cornstarch. Remove from st and cool. Serve with cream

FISH IN JELLY

ounds fish, boiled

y

Prepare the jelly made with lemon, chopped celery or cabbage, and allow to set. Then place the boiled fish in it and add more jelly, to cover the fish.

Vhen this is served to children, a Slavic dish called Quenelles calf's liver dumplings is an appetizing accompaniment, but uld be given infrequently.

QUENELLES

pound cooked calf's liver

ablespoons beef marrow

rjoram

on rind

ic, salt, mace, sugar

d crumbs

Skin the liver and remove the veins. Cook and mince the meat. Combine two tablespoons beef marrow or butter, a pinch of marjoram, grated lemon rind, a clove of garlic (chopped), salt, a pinch of mace, and pepper. Add enough bread crumbs to make the mixture, to which the minced meat has now been added, neither stiff nor thin. Form into balls and cook for ten minutes in boiling soup.

ARMENIA, SYRIA, TURKEY, AND GREECE

icking up our bags and trusting ourselves again to the plane, leave the Slavic States and land in the Orient among the ienians, Syrians, Turks, and Greeks. The majority of these ple live in mountainous regions or in the foothills, much in open, and their food naturally corresponds to their environt. Many of their foods simulate those of other countries, le others do not. The herds of sheep, goats, and cows are e, and an abundance of milk is used in the homes. Chickens, ks, and geese provide eggs. In addition, butter, cheese, wheat, ns, dates, figs, potatoes, squash, onions, and the omnipotent ic contribute to a balanced nutrition. Their favorite dish ears to be one composed principally of lamb or other meat the addition of rice and nuts, such as chestnuts, hazel, and achio nuts. Delicious wild honey often takes the place of sugar in sweetening their confections. Eastern cookery is dependent upon the use of extravagant and expensive in-

gredients, as is the Occidental, but is influenced rather by the flavor of each individual article used in the making of the different dishes. As with all Eastern peoples, there is an overindulgence in fats and in fatty foods, but, on the other hand, the foods are not overspiced or over-flavored. Animal fats are eaten instead of butter. The children grow strong on goats' milk, coarse bread and cracked wheat boiled in milk, a diet which should be more universally adopted. To these people, the world is indebted for Matzoun and Yoghourt, two food products which combine the qualities of a beverage and a food.

The following recipes may provide an addition to an otherwise commonplace diet. The national diet of the Turks is Pilat pilaf; of the Armenians, Herissa; both are good for children.

PILAT PILAF

5 cups stock
2 cups rice
2 tablespoons olive oil
salt and pepper to taste

Place the washed rice in a deep vessel. Fry it well in the oil and add the stock. When nearly done, remove it to the back of the stove and allow it to cook slowly. Put a piece of muslin under the lid, letting it fall a little over the brim, to prevent the steam from falling back into the kettle. After ten minutes stir the rice lightly with a perforated spoon, then place it over a hot oven until moisture is evaporated and rice almost dr[y].

HERISSA

1 lb. lamb or chicken
10 cups stock
2 tablespoons butter
3 pinches cinnamon
pepper and salt to taste

Boil the lamb or chicken with the bones for at least one hou[r]. Spread into fine thready piec[es] with the fingers. Soak in wat[er] the special wheat prepared f[or] this purpose, from eight to t[en] hours. Then boil the meat an[d] the wheat in half the meat brot[h], gradually adding the remaind[er]. While it is boiling, stir an[d] pound constantly with a wood[en] spoon. Pour over butter a[nd] powdered cinnamon to taste.

ASHOUREH

1 pound wheat
½ pounds sugar
½ cup seedless raisins
½ cup peeled pistachio nuts
½ to 1 teaspoon rose water
¼ cup chopped hazelnuts
¼ cup chopped walnuts
½ cup chopped almonds
1-2 pinches powdered cinnamon

ak the wheat in water from ten to twelve hours, then, after ashing well, boil in twice its volume of fresh water, until the heat cracks. In a separate vessel boil the sugar in an equal nount of water until two thirds of it remains. To this add the isins and the pistachio nuts. Then pour all this into the boiled heat and continue boiling a little longer. When this is done, ke it off the fire and add rose water. Chop the hazelnuts, alnuts, almonds, and roast them slightly in a pan on a moderate e. Then spread them over boiled wheat mixture, alternately ting on the powdered cinnamon.

Wishneh, a fruit compote, is excellent as a member of the lanced food group. It can be made from sour cherries, all kinds berries and figs, pineapple, and pumpkin, as described below.

WISHNEH

½ pounds sugar
1 pint plain water
½ lbs. sour cherries, with stones
1 teaspoon lemon juice

Bring the water to the boiling point and add the cherries. Allow them to cook until tender. Add sugar and lemon juice and let mixture continue to cook until the sugar is dissolved.

The knowledge of food combinations possessed by people of e East seems to be greater than that of any other race. Their oking is rich in flavor because of the number of the ingredients ed. Take as an illustration this Armenian dish as a weekly ssert for the children.

SUDOLI YOUMOURTA

cup sugar
cups milk
eggs
orange
t and pepper to taste

Break the eggs into a saucepan. Add the milk and sugar and then the orange, after it has been cut into small pieces. Season this mixture to your taste and stir well. Cook in a double boiler over a moderate fire until the mixture is fairly thick. Spread over it lightly some burnt sugar.

For an active, growing, athletic boy or girl, this Syrian stew is a good, well balanced ration.

SYRIAN STEW

2 cups raw mutton
2 tablespoons fat
3 tablespoons flour
2 cups string beans
2 onions
2 cups tomatoes

Dredge the meat, which has been cut into cubes, with the flour, and brown it in the fat. Put all the ingredients into a stew-pan, scraping from the frying pan all the flour and fat. Add enough water to barely cover it. Cook slowly until the meat is tender.

Before embarking for Japan, we pay a brief visit to Palestine and sample some of its many food concoctions. Oriental peoples, as has been said, eat a great deal of starch and sugar, a number of their foods being rich in these substances. Many of their dishes, however, are very savory and appetizing, but some foods, such as pickles, cabbage, etc., preserved in vinegar only, are rather too sour for consumption by children. The two following recipes from their dietary are excellent, and in the summer especially form nutritious and cooling foods which should be more generally introduced. They are known as borsht and schavel, the former a beet, the latter a sorrel soup. For good, wholesome borsht, with a delicious, natural sourness, there must first be a process known as vossel. Three bunches of red beets are peeled and cut in halves, then washed thoroughly, after which the mass is placed in a wooden or earthen jar and covered with tepid, soft water. The jar should be left in a warm place and covered with a towel. In about four days, the vossel will be ready. A crust of very dark Jewish bread improves it. When fully ready, it is placed in a cool place to prevent the process of fermentation from continuing.

BORSHT

Beets

Sugar

Consomme

Make a good consomme with meat and as many vegetables as are handy. When ready, bake a few raw beets in their skins, cut them into small pieces and sprinkle with a little sugar. Add this to the strained consomme, then the vossel to taste. Allow to boil. Serve plain or with sour salts.

SCHAVEL

pound sorrel
pound spinach
egg yolks
lt
tablespoon sour cream to each plate of soup

Chop the sorrel and the spinach very fine. Place both in an open kettle and cook in boiling water, adding salt as desired. When the greens are tender, stir two egg yolks in a bowl with a little salt, and add this hot mixture to the yolks, drop by drop, to prevent the latter from curdling. Place in a cool place first and later on ice. When serving, drop a tablespoon of sour cream into a soup plate, then add the cold soup while stirring vigorously. If desired, chopped hard boiled eggs may be served with it.[50]

JAPAN

In sampling Japanese cooking, we are reminded that it is ractically the same as that of the Chinese, as both nations ring from the same racial stock, and, dietetically speaking, are in. Japanese and Chinese dishes are savory and most agreeable the taste, are easily digested and metabolized, for with these eoples cooking is a fine art. Their foods are never underdone d never over-cooked, and every child should be early trained to joy them. Take, for instance, Sashimi.

SASHIMI

sh
egetables
oyu

The fish is skinned, cleaned, and cut into fillets about one tenth of an inch in thickness. Arrange on a dish and garnish with fresh, thinly sliced vegetables. It is best eaten with Shoyu, an especially prepared sauce containing pungent condiments blended with shredded Japanese horseradish. Boiled young bamboo sprouts, cooked in this Shoyu, are delicious to serve as a vegetable.

INDIA

India is the home of curry, delicious and appetizing, especially in this hot, humid climate, but rather too highly spiced to be enjoyed by a wavering stomach after a stormy voyage. However, *chicken pilau* finds a ready dietary response. It is prepared as follows:—

1 chicken

½ pound rice

¼ pound butter

2 onions, medium size

sage and thyme

cloves and cinnamon

salt and pepper

Boil the chicken. Slice the onion finely and fry in butter. When well browned take it out of the pan, and in the fat remaining, fry the rice until that also is browned. Put the rice into a saucepan with a little of the chicken stock and the spices. Cook until the rice is tender. Cut the chicken into pieces and mix with the rice. Last of all, add the onion. While delicious and delicate, this dish cannot be served to children indiscriminately on account of the frying.

SOUTH AMERICA

Beginning to suffer from homesickness, we now hasten homeward by way of South America. Reluctantly, chupe is put aside as too rich, and we order instead Spanish rice, delicious, tempting, appetizing, and nutritious.

JAMAICA

Northward Ho, and we are granted shore leave long enough to stop off at Jamaica and to enjoy a recognized luxury, *Jamaica cream,* incidentally a delicious treat for the children back home.

Melt ½ ounce of gelatine in a little milk. Peel and cut up eight bananas. Mix the fruit well with two ounces of caster sugar, gelatine, and one half pint of whipped cream. Press into a mold and serve cool.

SCOTLAND

We continue our journey, north-eastward, and pay a short visi to Scotland, where girdle scones, a truly national dish, ar popular.

GIRDLE SCONES

½ pound flour
½ ounces margarine
½ teaspoonful of carbonate of soda
1 teaspoonful of cream of tartar
1 teaspoonful syrup and salt to taste

Mix the flour with milk to a free dough. Roll very thin. Then cut into a three-cornered shape. Bake in the oven or girdle, first on one side, then on the other.

NORWAY AND SWEDEN

Next, a hasty visit to the land of the Vikings. It requires no ersuasion to enjoy a dish of savory gratin of fish and shrimps. he portions are generous, as befits the hospitality of the people.

GRATIN OF FISH (WITH SHRIMPS)

pounds fish
tablespoons butter
tablespoons flour
pint shrimps
tablespoons grated cheese
tablespoons bread crumbs

Boil three pounds of filleted plaice fish for twelve to fifteen minutes. Make a sauce of two tablespoons of butter and four tablespoons of flour with some of the fish stock and some cream, and season as desired. Mix about one pint of shrimps into the sauce. Place the boiled fish in a baking dish and pour the sauce over it, covering it well. Sprinkle over the whole two tablespoons of grated cheese, two tablespoons of butter. Bake in a hot oven until golden brown. Serve immediately.

HOLLAND

Holland tempts us with Snert, which is prepared as follows:

SNERT

- 2 pork trotters (pig's feet)
- 2 ounces butter
- ½ pint split peas
- 4 pints water with some salt
- 4 leeks (or onions)
- 8 stalks celery

Wash the peas well and soak them all night in four pints of water. The next morning, cook them (in the same water in which they have soaked) for two hours over a slow fire. Strain through a finely meshed sieve. Cook the pork trotters (for children we use lamb instead), for an hour in the strained pea soup. Add the vegetables, cut into small pieces. Then add the butter and cook the whole until the vegetables are done. Serve the food in the same vessel in which it has been cooked.

FRANCE

France is the land of good food. Judging from the comments of rapidly moving and misinformed tourists, it is also the land of over-rich dishes. This is not true, for most of the foods are simple, well prepared, savory, and very nourishing. The following dish has proven very attractive to children.

FILLET OF FISH

- Fillets of fish
- butter
- salt and pepper
- juice of two lemons
- vinegar, oil, onion
- tomato puree, herbs

Place the fillets of fish in a dish, side by side, with the butter. Season with a little salt and sprinkle sparingly with pepper and the juice of one lemon. Melt a little butter in a dish and pour it over the fish. Bake in a covered dish. Pour the sauce in which the fish has been cooked into a bowl. Add the juice of a lemon, a little vinegar, a little oil, and the puree of fresh tomatoes. Then add herbs and small pieces of onion. Beat the sauce well and pour it over the fish one hour before serving.

GERMANY

Now, directly homeward bound, our last stop is Germany. One might expect that German cooking would be in keeping with the austere Teutonic temperament. This characteristic, however, does not appear in their foods, of which the following may serve as an example.

BEARS' PAWS

½ pound sugar
½ pound butter
½ pound flour
½ pound chopped almonds

Mix all the ingredients together very thoroughly. Then press the mass into a small, shallow cake tin which has been well buttered, and bake to a golden brown.

Admittedly, many countries and many peoples (where cookery is a fine art) have been passed by—Spain, Russia, Belgium, England, the Argentine, and Brazil are some of the lands not represented on our food journey. Many countries lying next to each other have identical foods, and it is for this reason that we have generalized in the dietaries herein contained.[51]

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CHAPTER 14

PHYSICAL AND PSYCHIC STIMULI

ENVIRONMENT

ENVIRONMENT may be represented as a Medusa-like composite which spreads its activities over all phases of the child's existence. A detailed classification is, in consequence, almost an impossibility.

Conklin defines environment as all those forces lying outside the individual and considered from the standpoint of the entire organism. On the other hand, viewing it from the standpoint of the organ or cell, it comprises the surrounding organs, cells, or fluids of the body. Environment is then classified as internal, or intrinsic. Environmental factors are known as stimuli. External stimuli may be transposed into internal stimuli. They are chiefly energy changes of a physical or of a chemical nature. Environment may also be classified as physical and psychic. Under the heading of physical stimuli are seen all sorts of variations; mechanical, thermal, electrical, radiant, light, density of medium, gravity, and centrifugal force, etc. Some of these terms may be more simply defined as physical exercise, effects of heat and cold, electrical discharges in nature, the effects of sunlight; others may be seen as effects of play, freedom of action, stimulation from sports, of hydrotherapy, clothing, and sanitation.[1]

Examples of psychologic stimuli are education, mind training, the influences of the sciences and of the arts, the effects of home, church, and school life, certain methods of discipline, and the beneficial influences of social and economic surroundings, as well as the psychic stimuli of music and color.[2]

Internal or intrinsic stimuli are represented in such chemical processes as oxygen necessity, carbonic acid formation and water, metabolism, secretions of the ductless glands, and stimuli arising from the nervous system, and from substances not found in normal development, such as acids, alkalis, alcohol, tobacco, etc.

The effects of general as well as specific stimuli should be considered. As a rule, during the developmental period of the child, certain stimuli do not call forth a perfectly specific and definite response of the organism and various stimuli may even

oduce the same result.[1] All living organisms, in their active ase of existence, possess the property of reacting to stimulan. In children this reaction takes place chiefly through the ermediation of a special substance called nerve tissue. The muli arousing its activity may arise either in the external orld or within the organism. The response to external stimuli ay consist of movement of a defensive or of an instinctive ture. The response to internal stimuli, on the other hand, nsists of a coordination of the activities of the various organs sociated in the performance of a definite act, such as secretion d the movements of the alimentary canal which occur during gestion, the regulation of the heart rate, and of the calibre of e arterioles in the circulation, the maintenance of equilibrium d of body posture, as well as of multiple other similar or ssimilar effects. Beside these biologic phenomena, the child's alth is maintained and disease is changed to health, other facrs being equal, through a higher power; that of consciousness, ilt up of the sensations resulting from the action of stimuli ising in the external world, sensations of sight, hearing, touch, nell, and taste. Through this consciousness the higher processes imagination, judgment, and reasoning are built up.

These cognitive states, either agreeable or disagreeable, may, turn, bring up a mental reaction, an emotion, a condition voring to a marked degree the health or ill health of the child, rough the psychic centers. They and their emotional reacons control certain movements, such as gestures, speech, locootion, etc.[3] Indeed both the physical and mental propensities the child's mind and the physical possibilities of his body spond in their development to the subtleties of sensitivity, to flex motions, to the persistence of the effects of environmental imuli and to nutrition. This sensitivity, which is the ability to ceive and respond to stimuli, is the fundamental property of otoplasm whether of germ or of body cells. A single stimulus om whatsoever source may produce changes in the organism hich persist for a longer or for a shorter period of time, but if second stimulus occurs while the effect of the first is still esent the response to the second may become weaker.

Sound is a good illustration. Protoplasmic cells have the ower of storing up the effects of stimuli. It can be readily seen, erefore, that cell growth and cell function depend directly oon the activity of the living tissue within the cell, and indictly from the specific character of the stimuli from without. very child is the product of its cells, therefore of the germ lasm and of the soma.[4]

REGIONAL SEASONAL AND PHYSIOLOGIC ENVIRONMENT

Infants and children who have inherited sound constitutions and who are properly nourished can safely leave one region for another, can eat unfamiliar foods and eventually acclimatize themselves better than children of less favorable inheritance and nutrition. In 1845 or 1850, settlers in the Mississippi Valley tried to cultivate the potato. A certain beetle, quite alien to this form of nourishment, soon learned to thrive upon it.

On the whole, children as well as animals do better if they approach a distinct change in regional environment and in nutrition by easy stages. Changes in infant food modification had best be built up gradually from the old rather than begun anew. It cannot be denied that some children appear to be physiologically and often morphologically dependent upon certain environmental conditions, the absence of which may limit their growth and development. Often regional and nutritional conditions other than those to which the child is accustomed constitute limitations to both health and longevity. The forces of environment, both psychologic and physical, are often of a sensational nature. Startling accounts reach us from time to time from explorers, scientists and others as to changes in traits, growth, and development in migrating peoples, from changes in nutrition and from unusual surroundings.

Recently there appeared in an English Colonial paper a report, unverified, however, of a "baboon boy," discovered by the police of Johannesburg, South Africa, under circumstances which are said to have interested biologists and other scientists. In this account it was stated "on authority" that a native baby had been kidnapped when very young by baboons, and raised by a baboon foster mother, until it was several years old. The child had spent most of his time roaming the wilds with a herd of monkeys. After capture he was placed in an institution for mental delinquents, as he could not talk. He ate like an animal, preferring raw food to orthodox human nutrition. No viciousness, however, was observed at any time. After a while the boy began to lose fear of humans and became docile, although he still presented queer animal mannerisms, even after twenty-four years of civilization.

Environment can change the inheritance pattern of a species, as seen in the discoveries of Professor Beebe on his expedition to Haiti. There Beebe found a certain species of tarpon fish,

nuch undersized, whose body length should have been four eet or more, but instead was much under that. He found this pecimen in a body of water impregnated with sulphur, in a basin o arranged that fresh sea water could not enter.[5]

Environmental conditions may even influence the development of the embryo in no uncertain degree. It has, indeed, been re-peatedly shown by experiment that in the case of eggs develop-ng in water the presence of small quantities of certain chemical ubstances in this water produces a variety of structural ab-ormalities.[6]

It must be understood clearly that environment, whether physi-al or mental, cannot make manifest in the individual anything hat is not potentially present within him. Inheritance is a trictly conservative process which does nothing more than eproduce the earlier inheritance pattern regardless of all altera-ions in the appearance of the individual which the environment produces. It is known that individuals, identical as to their nheritance patterns even though they look different externally, an produce completely identical young. It is therefore obvious hat constancy of species would necessarily result if there were not also outside influences which change the inheritance mate-ial itself, and through it the inheritance pattern, so as to alter he possibilities of the reacting of the race. External environ-nental conditions may or may not exert a powerful effect upon he appearance of the individual. We have in mind twin girls, ndistinguishable in the early days both in appearance and char-cteristics, but later raised in localities miles apart. Now, wholly unlike in characteristics, they retain to a great extent, but not entirely, their similar appearance or phenotype.[5] Darwin many ears ago showed that no two individuals were identical and that ome of these differences were inherited.[7]

Indeed, the subtleties of environment strongly affect children. The quantity and quality of food, of light, of air (oxygen, car-bon dioxide, humidity), of poisonous pollutions such as dust, smoke, illuminating gas, etc.; all are environmental factors. Other contributing agencies are exercise, daily duties, spiritual and mental impressions of one type or another, such as the unhappi-ness of parents, leading possibly to divorce, etc. Early childhood s that period of life when strong environmental stimuli, mental and physical, are much more impressive than in later years. A child's health, his growth, his mode of speech, even his be-havior may be greatly modified by feeding, training, and educa-tion, all environmental accessories, but the color of his eyes

and hair are determined before birth. The child, too, has a number of congenital characteristics which arise fundamentally from his constitution at the time of birth. Modifications may, in consequence, arise at this time, following the development of the foetus in the uterus.[8] In animals whose young develop within the body of the mother, artificial alteration of the chemical composition of the mother's blood has, in a number of instances, modified the nature of the offspring. Indeed, the mother while in labor may be profoundly impressed mentally by external conditions so that modifications of constitution appear in the child. Economic depression, an unhappy home life, mental and physical cruelty, unemployment, mental with consequent physical depression, the modern unrest among women of all classes, the moral and physical effects of drinking, smoking, and of a hectic night life are only a few of the factors which often tend to promote peculiar characteristics seen in the child before and after birth.

From the earliest times it has been believed that species might be transmitted by environmental changes and that even life itself might arise from lifeless matter through the influence of favorable environmental factors. As he grows older the child may in a sense be affected outwardly as well as inwardly by environmental conditions. Just as in a flowering plant it sometimes happens that the color of the flowers changes with age, one sees occasionally a flaxenhaired child turn to a brunette at maturity.[4] However these changes may admittedly arise from heredity.

Both animals and plants which differ in certain factors may show a difference in character only at certain ages, or may not show the same difference at all ages. For instance, in the Drosophila flies, those with a factor for pink eyes are easily distinguished from those with a factor for purple eyes when the flies are young, but as they grow older the eyes of both assume a dark purplish hue and become practically indistinguishable from each other. Environmental conditions which are harmful to some children are not so to others. Furthermore, many adverse and obscure environmental agencies, whether of temperature, moisture, size of play area, type of soil, absence of certain foods, as legumes, vegetables, meats or fish, fruits, etc., may react for good or bad on the health, growth, and longevity of the child, particularly if he had formerly lived under more favorable circumstances.

Good or bad reactions as seen in the child may spring from differences in temperature, often between places in the same latitudes, from close proximity to large bodies of water, from air

ırrents, from seasonal plenty or scarcity of rainfall, from marked ifferences in soil, forest or moorlands, or even in drinking aters which vary in their chemical composition. There have een reports of cases under adverse conditions of environment ı which whole families were depleted or wiped out. Such in-ances occur in nature. The rocks and soils of many regions ɔntain fossil remains of thousands of extinct animal forms. Iunters tell us that diseases, droughts, exceptionally cold eather, the multiplication of enemies, changes in the substances eld in the water in the case of aquatic forms of life, increased ıoisture, and other agencies have so destroyed wild animals and sh that large areas are deprived of animal and aquatic life. ote the scarcity of quail at the present time in southern Michi-an, following several unusually cold winters, and the loss of ild animal life on the pampas of some parts of South America nd Africa, from thirst alone.[9]

Morgan gives instances where certain flies acquire abnormal bdomens if raised in a dry bottle, but appear perfectly normal reared in a wet one.[4] Children who are best suited to their nvironment are the ones who survive and produce healthy off-ɔring. Their descendants even more readily adapt themselves to his environment.

If one is curious enough to measure, weigh, or classify any haracter shown by children, particularly in adolescence, he may nd great variability. Variability is however more evident in nsects than among humans; for instance, a change in the kind of ɔod furnished to the larvae of a certain moth such as from oak eaves to walnut leaves, produces differences in the color of the dult. Certain aquatic animals, too, have different forms of ody, depending on whether the water in which they live is resh or salt.[6] Variations in children are ascribed to differences n experience, environmental stimuli which they have encoun-ered in the course of their young lives. Others may be con-idered as due to the quality of nutrition, to the degree of physi-al and mental development, and to heredity. For example, if number of boys in a grammar school were to stand side by ide, one might easily distinguish which characters of those boys vere hereditary and which environmental, which caused the dif-erence in size alone. If those boys possessing a dominant qual-ty for tallness are in maturer years, married to young women ɔossessing a recessiveness for shortness, their offspring will be aller than the average. But then nature steps in and further ɔrogress in height is abated.[7]

EXERCISE

The bodies of infants and children are physiochemic, self-repairing mechanisms, and therefore require a constant renewal of foodstuffs to insure a continual supply of energy. Some form of exercise is necessary to motivate this supply for digestion and metabolism. Gentle exercise increases the secretory activity of the stomach, which may be recognized subjectively when the infant coos, flings its arms and legs about, kicks and rolls, or tries to lift itself from the floor by its arms and legs. Similar digestive reactions from light exercise take place in the older child, but severe, protracted exercise or short, violent bouts produce a diminution of the stomach acids, followed by a delayed but greatly increased secretory activity.

The effects of active exercise cannot be too carefully considered. Mild exercise may affect one child more than severe exercise does another. When the child exercises, he benefits from that exercise only in proportion to the pleasure he gets out of it. Before the age of puberty, a normal, naturally strong and healthy child may suffer from restrictions to his freedom in play to such an extent that his organs do not properly mature or develop. Such a child is ill prepared to compete in athletics or any other form of severe exercise after puberty. Under these conditions, properly selected nutrition offers the child but little aid, and metabolism is greatly disturbed.

In both infants and older children, gentle exercise hastens the emptying time of the stomach, while severe exercise delays it. Exercise governed by the needs of the child is therefore a natural regulator of the nutritive functions, working for economy and efficiency. Too little exercise lessens the vigor of the muscles of digestion and there is a sympathetic effect on the voluntary muscles. The digestive musculature grows weak, presenting a condition known as atony of the digestive apparatus. In the muscles of the alimentary canal this condition becomes a very serious one. Two fundamental processes are taking place in the alimentary canal during the process of nutrition. One is an elaborate set of chemical reactions combined under the technical term "hydrolysis," and another set of more mechanical changes due to muscular movements. It is inconceivable that food can pass down about thirty feet of a distorted and convoluted tube without muscular movements of the body to move the bulk along. In the intestine are longitudinal and circular muscle fibers and any influence which lowers the tone of the skeletal muscles will also lower the tone of the smooth visceral muscles.

When a child has lain in bed for a long time, inert and pas-ve. the skeletal muscles are weak and flaccid, the tonicity of ie digestive apparatus is correspondingly very weak even after roper nourishment has been administered. Under certain debili-ting conditions the child may eat abnormally, as evidenced in ithisis, but owing to this engorgement, the body cells cannot irn up all the food, and a loss of vitality results. In fact, the gestive apparatus will suffer in sympathy with this lowered gor of the voluntary muscles.

The neuro-musculo-glandular mechanism of the villi also markedly affected. This mechanism, together with the valvulae onniventes, presents an actively adaptable structure for absorp-on. Since these villi are situated on the valvulae conniventes id present a wide surface area, obviously the absorptive terri-ory of the intestines is increased. The villus itself is a complex ttle organ, for, beside its versatile and essential wall of columnar oithelium, it consists of smooth muscle, autonomic nerves, lac-eals, blood vessels, leukocytes, and connective tissue. While it quite impossible in these pages to explain all the details of osorption, it can be readily surmised that a lack of proper xercise does severe damage to the absorptive powers of this elicate mechanism.

The result of too little outdoor exercise on the child's nutri-on as it affects the nervous system must also be considered. he nervous system, like the muscles, loses tone from a decrease exercise, particularly exercise in the open air. This loss of one decreases the requisite tone in the digestive organs. When ie nerve cells are not normal in tone, there is a diminished imulation from the spinal cord and the sympathetic nervous ystem tends to relay messages in a sluggish manner, or not at all.

This lack of exercise also markedly affects the nerve centers, or the muscles controlling peristalsis of the intestines are rongly inhibited. In the older child open air play, sports, and ames react upon the secretory organs, affecting both the quan-ity and quality of their secretions, but without them the appe-ite remains poor and uncertain and cannot be stimulated to id in the digestion of the ingested food. During these periods here is often an unfortunate tendency on the part of the parent r physician to force food or to prescribe it at too short intervals efore the appetite juice can reform. At times an abnormal or seudo-appetite may make its appearance. A chronic condition nay result which shows itself in a weakened musculature, a eavy, soft flabbiness of the body, and a perverted appetite. Diatheses, in our opinion, may be discovered at this time, as

well as previously unrecognized disease potentialities. Waste materials circulate in the blood, and the excess of unoxidized nitrogenous material impedes the function of the kidney, and dangerous dysfunctions may develop in consequence.

Fortunately modern science clearly differentiates between natural and unnatural obesity; between a somatic and an inherited dysfunction. In permitting the child to exercise, certain precautions should be observed. Never permit a child to exercise violently after a meal. A general muscular congestion may follow, thereby robbing the stomach of blood necessary to elaborate its secretions. That does not necessarily mean that no exercise may be indulged in, for often light games may be played to the benefit of nutrition. The playfulness of a healthy child before breakfast tends to increase the action of the heart and consequently the general circulation, and promotes adequate digestion, absorption, and metabolism. Feces elimination also is greatly facilitated.

Many children in the cities are addicted to sweets or to fats out of all proportion to their economic needs. Muscular exercise stimulated by these energy-forming foods brings about their increased oxidation, with a correspondingly increased elimination of carbon dioxide. There results also an increased peristalsis. Moreover, with the enjoyment of exercise comes a heightened power of respiration, a greater demand for oxygen. The diaphragm expands in consequence of this forced respiration, and in its downward pressure there results a gentle massaging of the liver, gall bladder, and transverse colon. This action also lightly stimulates the glands of these organs.[10]

During severe exercise, it is quite impossible for the child to take in as much oxygen as is needed. Lactic acid is produced and lactates are formed by the action of oxygen on the bicarbonates. Upon recovery from exhaustive exercise, the lactates become oxidized. This is seen in the increased oxygen consumption, which continues for a considerable time after the exercise has ceased.[11] Following active exercise there is a marked capillary dilatation, due, probably, to the lactic acid and carbon dioxide. At the same time, impulses appear to pass up the sensory nerves from the active tissues and bring about a dilatation of the vessels supplying some part or parts.[12]

During vigorous exercise, the demand for extra oxygen by the tissues results in a number of important physiological changes:—(1) a very great increase in breathing rate, (2) an approximate doubling of the output of the heart per beat, (3) doubling o

e heart rate, (4) raising the arterial pressure so that the blood ws in greater volume per minute through the expanded capil-ries of the region where activity requires a greater oxygen pply, (5) heightened diffusion rate or exchange of gases in the pillaries of the lungs and in the contracting muscles, (6) the dden increase in the number of the red blood corpuscles.

The rate of breathing will vary, (1) proportionately with the gree of activity of the body, meaning the metabolic rate, (2) th the reaction of the blood there is a maintenance of the proximate oxygen tension in it. This is controlled auto-atically by the respiratory centre. During exercise the arterial ood, with its increased pressure in diffusion of carbon dioxide, thes the respiratory centre. No storage of oxygen is provided the child's organism, therefore continued respiration is essen-l to its life. During exercise lactic acid accumulates in the uscles and muscular contraction is somewhat impaired. With olent exercise lactic acid is probably temporarily neutralized d then burned, and subsequently reconverted into glycogen. olent exercise stimulates metabolism, but the diet should be ell balanced to gain benefit from it. Pulmonary ventilation es in proportion. Deeper and more frequent inspirations are obably initiated by impulses from the cerebral cortex and are aintained by the effect of the increased oxygen in the arterial ood on the respiration centre. The passage of air in and out the bronchial tubes is more rapid and the muscles controlling e bronchi, like those of the arterioles are controlled by nerves the sympathetic system.

With increased respiration there is an approximate doubling the heart rate and a heightened arterial blood pressure which arantees blood to inactive regions and assures a large volume the active counterparts where the need for oxygen is greatest. eside, there is a heightened diffusion rate or exchange of gases the capillaries of the lungs and in the contracting muscles. here is also an increase in the number of the red blood rpuscles.

The increased rate of circulation following exercise allows less me for the red corpuscles to unload carbon dioxide, take on ygen, and to perform the reverse process in the muscle. Dur-g the child's muscular exertion, not only is carbon dioxide oduced but also extra heat, forcing a more rapid unloading carbon dioxide from the red blood corpuscles. This results in greater diffusion from blood to lymph and consequently in a ore active diffusion, the net result being that the cells receive

oxygen in accord with their greater need. Still another result of added exertion is an increase in the number of red blood corpuscles to assure sufficient oxygen. Henderson and others have shown that even in a brief period of exercise the increase in hemoglobin may exceed 20 percent. If the child has been spoiled or unduly restrained and its play and physical energies have been curtailed, continuous daily exercise over an extended period may bring about a gradual destruction of the red blood cells. Brous has demonstrated that increased exercise probably causes a progressive decrease in hemoglobin. If, however, a child is permitted natural activities, he becomes trained and hardened, a consequent balance is maintained between red blood cell destruction and regeneration.[13]

INFLUENCE OF EXERCISE ON METABOLISM

The respiratory quotient (CO_2;O_2) is seen to rise during and after exercise owing to excessive lung ventilation produced by the increased hydrogen-ion concentration of the blood and tissues. A considerable amount of carbon dioxide is thus driven off and then taken in later on recovery, in due order, as the lactic acid disappears, to enable the tissues to keep their normal hydrogen-ion concentration, when the respiratory quotient will be normally low. There occurs at the same time, after vigorous exercise, a transformation of fat into carbohydrate. Complete recovery of a muscle is the fairly exact return to the initial intake of oxygen and carbonic oxide output, differing with the form of exercise and the constitution of the child. With sufficient rest periods, not only is recovery established in the muscle but in the cell this rest period is also appreciated, as is seen later in a fuller and greatly increased function.

The relationship of oxygen and carbon dioxide in metabolism has already been studied in the pages devoted to metabolism. It might be suggested that probably after a rest period the body has transferred its oxidation entirely to the side of the carbohydrates. Now we know from the work of Cannon that emotion and excitement which may be associated with any severe exercise cause an increase of sugar in the blood and the child's body oxidizes it to the exclusion of all other material, the sugar being completely burned up. During the rest period one may easily visualize the cell as taking on an added stimulation in transforming and oxidizing other nutrients. Thus exercise and fatigue contribute in their action on the cell a stimulating function, following which come growth and development.[14]

CARDIAC CHANGES FOLLOWING ACTIVE EXERCISE

So delicate is the adjustment of nature's mechanism that from he circulatory changes in the child's organism after exercise here result an increased digestibility, a heightened metabolism, uick mental reactions, and recognized tendencies toward growth nd development. The increased return of the blood to the ight side of the heart brings about a large increase in the ardiac output per minute. There is a diminution of the normal agus restraint of the heart and a stimulated sympathetic nerve ctivity, partly psychic, and continuous by reflex action, once he exercise has begun.

When the pressure in the right auricle rises, impulses pass up he vagus to the medulla to inhibit the cardio-inhibitory and to timulate the cardio-accelerator system, so that there is a rise in he heart rate. It is also important for the over-anxious parent o realize that the oxygen want evidenced after exercise may ause a direct stimulation of the sympathetic and a reduction of he normal vagus restraint, thus making it possible for the eart to speed up in spite of the high blood pressure and the lepression reflexes. In very severe exercise the rate and the force of the heart may be still further increased by the secretion of drenalin. Subsequently, if the exercise is prolonged, the body emperature rises and the hot blood then stimulates the heart egulating centre and causes a dilation of the blood vessels of he skin.[12]

GENERAL VASCULAR CHANGES FOLLOWING EXERCISE

Following vascular changes there is a marked rise in blood pressure, usually caused by a general constriction of the blood vessels. The vessels of the alimentary canal and of the skin are affected before the body temperature rises. Also the spleen is apparently constricted. This may be due, in part, to a stimulation of the vasomotor centre by the afferent nerves and by carbon dioxide produced by the active muscles. The rise in blood pressure is also because of a greatly increased cardiac output.

The compression of the valved veins of the limbs propels the blood centrally, while the carbon dioxide stimulates respiration. Each descent of the diaphragm raises the pressure in the abdomen, while at the same time the intrathoracic pressure is reduced and is in consequence drawn into the thorax.[12]

PSYCHIC EFFECTS OF EXERCISE

Many may recall the athletic prowess of their younger days and their varied reactions before a sport competition. Possibly there was an unrecognized acceleration of the heart, a general constriction of the blood vessels, a marked urine output, and an increased mental activity which resulted in many other body reactions. There was also a rise in blood pressure. Then, however, the vasomotor system functioned properly; the blood pressure rapidly returned to normal. Quite the same reactions take place in the constitutionally sound child. If, however, the child is unhealthy the vasomotor centre may be inefficient, the cardiac acceleration all the more marked, and the worries of the parent justifiably increased.

Space forbids us to speak of the many other organic reactions in detail which psychic reaction through exercise and play-freedom bring about in the child's body. There may be mentioned, however, adrenalin secretion, the formation of ammonia, the manner in which the carbohydrates are utilized, the intramuscular and capillary pressure, the formation of lactates, and of the alkali of the blood, the carbon dioxide content of the blood, and many others. A proper dietetic regimen, followed by a speeding up of the circulatory system through exercise, is a strong factor in maintaining health in the normal child.[12]

VARIOUS FORMS OF ACTIVE EXERCISE

Many diverse opinions exist today as to the advisability of advocating a system of gymnastic exercises to motivate growth and development, to strengthen and correct weak muscles in those children below the age of puberty. Such exercises certainly tend to add grace and plasticity to the body in a period before competitive games are begun. If systematic exercises are to be considered at all, they should be in the form of military-like marching and corps formations, and then develop into more or less organized play. This initial period should be made so simple that the child can easily continue similar exercises at home. No organized exercises should be attempted before the second year at the earliest. The first two years of the child's existence are critical ones, for during this time his organic substructure is being formed and any attempts at meddling by mechanical or by other artificial devices are contrary to nature. These years should be devoted to a study of the child's nutrition, to the

ilding up of the skeleton and the organs, and also to the rmonizing of nutrition and environment. In fact, experience d observation show that certain biologic adjustments take place thin this period which make it inadvisable to start gymnastic ining too early. Exercise should start with gentle movements the head, arms, trunk, and legs as expressed in simple games d play, expanding later into a more vigorous form.

The stimulation of certain muscle groups exclusively not ly tends to disrupt the balance of the child's internal mechan- n through disorganized function, but often produces a stunted disproportionate musculature. The lifting of heavy weights o, during the adolescent period, produces musclebound and aceless individuals. Simple apparatus which permits of quick ther than slow muscular movements far outdistance those ethods. Unless the child's nutrition and environment are of e best, unless his growth and development are satisfactory, and less he likes both the instructor and the form of exercise, he ll receive very little benefit. The personality of the instructor a most important factor.

A child of robust constitution exercising all groups of muscles the various sports usually attains distinct grace of form and aring. When of unsound constitution, manual manipulation massage for the purpose of restoring health and vigor, as well for strengthening muscles and tendons long in disuse should advised, but must be performed slowly and carefully, avoiding ny jerking, jolting, wrenching, or pulling movements. Where e child undergoes muscle manipulation on a table, care should taken that the table is steady and provided with some sort of iling to prevent a fall. Normal children should exercise in nall groups or even alone, perfection should not be insisted pon nor should punishment of any kind be administered. No ompetitive or "showing off" methods should be employed and cheery operator rather than a grim one works to better ad- antage. In convalescent children there must be no set hours or exercising. It should come when the child is at the zenith f his daily strength, usually between breakfast and the noon eal. The exercises should be halted, says Neumann-Neurpde, hen the child begins to fidget or cries and screams. If the hild is frightened he must be calmed and assured before fur- her manipulation is attempted. Clothing should be suited to he time of year and the climate. The genitals should never be xposed. In very young children who cannot satisfactorily ex- plain their sensations, the manipulator should be doubly ob-

servant. There is no reason, however, for omitting the exercis until the children are older and can better explain their fea and wants.

In normal children simple forms of exercise are enjoyed gra ually, they become automatic and the youngsters will then exe cise of their own accord. This spontaneity is valuable in that establishes an incentive for other voluntary movements in pla and sport. Later on, praise and little rewards make exercisin doubly attractive.[15]

PASSIVE EXERCISE: MASSAGE

While it is necessary to insure some form of exercise, whethe active or passive, in the balancing of the child's metabolism primitive folk, for some unaccountable reason, often bind u their infants in some way so that free muscular motion is eithe restricted or lost. The Navajo Indian women and the Japanes women wind their infants in cloth wrappings and often stra them to inflexible boards or to slightly flexible wicker-worl baskets, which they carry on their backs. The African woman does likewise, but allows her infant greater freedom of move ment. Polish, Ukrainian, and Lithuanian mothers follow a simi lar custom.

The normal infant or child in health requires no passive exer cise to stimulate his metabolism, growth, and development rather he seeks to express his health and vitality in voluntary muscular movements. There may come a time in the lives of the same children, however, when, because of some inherited o somatic dysfunction, convalescing from contagious or infectiou disturbances, or any other cause which has unbalanced thei metabolism, passive massage is advisable. Superficial or deep massage performed by an experienced operator, is a far better form of treatment than are the body swinging exercises by feet or hands, forcible rolling, manipulations, and other devices em- ployed by some physicians. In our opinion, no other therapeutic measure in the entire armamentarium of remedies has been so misunderstood as has massage.[16]

BIOLOGIC EFFECTS OF MASSAGE

It is impossible to date the first work in the treatment of dis- ease by massage. If data were found, the language of the text and the style would probably not be understood or decipher- able. Pemberton and his co-workers found that, after massage,

the excretion of acid was not altered and that there was no evidence of a disturbance of the acid-base equilibrium of the blood. Nor did they observe an increased rate of nitrogen excretion, or of inorganic phosphorus and sodium chloride. The rate of creatinin apparently was not affected, for in no instance was creatin urea induced.

In general, it may be said that massage has no immediate or great influence on general metabolism of children per se, but its cumulative effects on the various metabolic processes probably lie, as Rosenthal suggests, in the mechanical impression on the circulation of the parts concerned. Where massage is indicated in the treatment of infants and children it is best performed in a warm room at temperatures from seventy-two to eighty-five degrees Fahrenheit. Massage, exercise, and exposure to the sun's rays or to those of an alpine lamp constitute a bond of agencies which possibly may replace or complement one another in the treatment of certain somatic disorders, such as trauma, acute or subacute rheumatism, or those conditions following sprains and bruises. Exposure to heat is a very valuable aid, as it promotes an increased respiration rate and an additional stimulation of the circulation, the former washing out the carbon dioxide from the lungs. Sweating is induced and a small amount of carbon dioxide, together with small quantities of other acid products such as lactic acid, are, in consequence, eliminated. Salt and some nitrogeneous constituents are also carried away in the sweat.

The urine normally contains carbon dioxide as well as various acid substances, among which may be mentioned the phosphates, sulphates, and the inorganic acids, which, following a systematic exposure to heat, are increased. The net result is the removal from the body of certain acid radicals, chiefly carbon dioxide, which brings about a relative alkalosis. This relative excess of alkali alters the reaction of the blood, and the alkali itself is eliminated through the sweat and urine, producing an alkali swing in each of them. This general condition of alkalosis of the fluids of the body following exposure to heat is in marked contrast to the results of exercise. Actively contracting muscles bring about the production of lactic acid in amounts sufficient to change the reaction of the blood in the opposite direction, namely, acidosis. This increased acidity may, in an active child, persist for fifty minutes or more after an amount of exercise equivalent to 3500 kilogram meters in three and one-half minutes.

Massage for normal children is unnecessary, but in convalescent and very young children its effects simulate those of regular exercise, for after massage, as after light exercise, there is

found no evidence of acidosis, there is no increase in the lactic acid of the blood, and the urine shows no constant increase in organic salts. Even in older children, the hydrogen-ion concentration of the blood following massage shows no change comparable with that following exercise. There may, however, take place a slight decrease in alkalinity, but there is no change in the percentage saturation of the blood with oxygen, such as follows the exposure to heat, and there is probably no evidence of a heightened rate of blood flow through the vessels.[16]

The important benefit which light, superficial massage exerts on the convalescent child lies in the effects of hand pressure on the capillary circulation. Carier has shown that light hand pressure produces an almost instantaneous though transit dilatation of the capillary vessels. Another advantage which massage induces is seen in the increased blood count, but, as is so often observed in nutritional anemias, this increase diminishes after a short time. The hemoglobin percentage is likewise raised, the increase being marked if the child is treated in a locality at a high altitude.[16]

EFFECTS OF MASSAGE ON CARBOHYDRATE METABOLISM

Carbohydrate metabolism, according to some observers, takes place in muscular tissue as it does in the liver. It can be readily seen that hand massage may stimulate this form of metabolism through its effects on the circulatory system. Manual or bimanual manipulation of the muscles should begin with the extremities, the feet or hands, and move upward to the thigh or shoulder. This method tends to return the often stagnant body fluids to the general circulation.[16]

THE CENTRAL NERVOUS SYSTEM AND MASSAGE

There is little doubt that through massage the nervous system contributes a reflex influence on the blood vessels of the parts treated, probably by way of the sympathetic nerve division. The dilatation of the small vessels of the internal region following very light stroking affords an illustration of the nervous mechanism in use. Is it not possible that blood vessels within this muscular roofing or beneath it may be emptied during massage, not alone by being pressed, but also from the reflex action of the nervous system? A mild stimulation or a sedative action may result; even, after prolonged or too strenuous manual manipula-

on, a feeling of fatigue may be present. In certain types of rdiac decompensation, particularly following contagious disses, we have felt that gentle stroking of the superficial skin rface of the child's body tended to compensate for the lack of at contraction of the muscles of the larger blood vessels which ccurs during exercise and which normally contributes to the eturn of the venous blood to the heart.[16]

PERSONAL DEDUCTIONS

Many persons believe that exercises for girls up to the age of uberty should be of an entirely different nature from those or boys at the same period. They consider that the body build f the girl cannot endure the vigorous sports of boys. This epends largely on the individual child. Many girls as well as oys who exercise strenuously are the better for it. In healthy oys and girls, if exercises are not indulged in before puberty, ne organs and tissues are not sufficiently developed and an undue rain during adolescence may cause an organic breakdown.

In many less favored children muscle manipulation by masage should be performed before puberty. In general, children f both sexes should be divided into two groups. One group is tocky and slow-growing, with organs well balanced and funcioning normally, and with a nervous system well able to withtand physical fatigue and emotional excitement. These youngters thrive on strenous athletics. On the other hand, there is he child delicate in build, often undernourished, and with oorly functioning organs. In addition, the nervous system is ndeveloped and unstable. Body growth and development have een retarded. For these children vigorous exercise would be letrimental. Light exercises or even massage are essential, but hey must be carefully supervised. Unless metabolism is properly balanced under any condition most forms of exercise do nore harm than good.[15]

It was Lavoisier who first pointed out that the supply of energy equired by the body for the performance of its functions was lerived solely from the process of the "burning up" of the food substances. In order to effect this combustion, oxygen is breathed n from the air and carbon dioxide and water, its combustion products, are passed out from the lungs during respiration. Obviously, other things being equal, the more violent the exercise the more oxygen the lungs will demand. The energy provided by this "burning up" is utilized in muscular contraction and in the maintenance of normal body temperature. The energy out-

put of the child's body may be expressed in the amount of oxygen the child breathes in. Naturally, with increased activity, more oxygen will be absorbed by the lungs, and the oxidation processes will thereby be increased. It follows, then, that food in greater quantity and better quality must be ingested if the body weight is either to remain constant or to increase. However, an increase cannot very well take place if a digestive dysfunction has been inherited.

This energy output is indisputably dependent on the type of child and on the particular build and structure of the organism, for no two children metabolize their food in exactly the same manner. A small, thin and weak, though active child has an energy requirement quite out of proportion to that of a child who is phlegmatic, large, and sluggish. The kind of life a child leads determines the number of heat units required; appetite alone is not a guide. A quiet, timid child a "good child," as the mother implies, who sits at home and plays with his toys, too lethargic and indolent to play with comrades of his own age, requires fewer calories, far less food of any sort than does the active, enthusiastic, sports-inclined individual.

The laity have always been obsessed with the fallacy that the greater the consumption of food, the greater the strength of the child. Even intelligent members of society believe that the more food consumed and the more completely it is oxidized by sufficient exercise, the more weight will be produced. Many children who eat ravenously remain at a certain weight, while others who eat less increase in weight.[17]

The relationship of body weight to body build is generally misunderstood. The inheritance of body structure and form, as well as the tendency to fleshiness or to leanness, follow along biologic lines. Violent exercise often induces additional weight in a child who is inclined to stoutness, while the same procedure will reduce the weight of one inclined to be thin. Undeniably, somatic factors tend to offset both conditions. The acid-base balance of the body should also be taken into consideration. A child tending to acidosis and unable to oxidize his acid-forming food intake, may, in spite of an inherited potentiality to stoutness, get thin, while one with a propensity to leanness may gain weight on alkaline foods. This has been observed in connection with excessive exercise. Many a mother has been driven to tears after a complacent visitor has commented on either the over- or underweight of her child. Finally there is, we believe, some sort of inherited internal regulating mechanism in the child's body which may automatically govern the weight.[17]

HYDROTHERAPY

he Indian squaw who asked a white woman why she bathed y, and was it because of a filthy wigwam, expressed an igno-e not so much greater than that shown by many people. ple in general consider only the cleansing effects of water, e ignoring its therapeutic value in its biologic reactions on nic function. Bath tubs filled to the brim with mushroom with coal, or with family laundry is a picture often seen ng the foreign born herded in the large cities. Of the two of water, internal and external, the latter appears to be some-t lacking in popular favor, judging by the "parfum" in evi-ce on city transportation lines.

he thought often comes to mind whether or not there has a real advance in the knowledge of water technique since the y days of its glorification. Hippocrates taught the physio-c effects of cold, warm, and luke-warm baths. At that time Indians, Egyptians, Persians, Assyrians, and Jews considered bath a necessity, both as a health measure and as a means trengthening the body. Among the ancient Greeks and Ro-s, cleanliness of the body meant purity of the soul. One s to mind also the elaborate hippodrome affairs of the time Nero, which possessed practically all the hydrotherapeutic hods in use today, but with the added attractions of theatre, aret, wine room, dance hall, and lounging spaces.

o understand the benefits derived from the scientific admin-ation of water, is to know the physiology, anatomy, and hology of the child's organism. The physiology of the skin n essential initiation to the study of hydrotherapy. Briefly, skin is an organ by means of which external water applica-s produce their effects upon the internal organism. It is a ecting cutaneous envelope as well as a vast secretory and etory glandular organ. Indeed the pressure of perspiration he sweat glands situated under the epidermis exceeds that nd in the large arteries. The proportion of urea, as well as er metabolic products excreted by the skin, may amount to four or five percent of that contained in the urine. The cess of perspiration is one of the most important physiologic siderations in hydrotherapy. It is regulated by the sudorific ve fibers from the sympathetic centres. This nervous appara-is very sensitive to temperature changes. Therefore these aceous glands are liable to become obstructed by cold and nulated by heat.

n important office of the skin is the heat regulation of the

body. This heat regulation comprises a vast system of blood vessels covering the entire cutaneous surface of the body. Heat is rapidly lost when the skin is warm and the surrounding medium cold. A cold bath contracts the blood vessels and approximates the skin to the temperature of the medium. The more blood present near the skin surface from a hot bath, the greater the loss of body heat. On the other hand, when the skin is contracted the blood recedes, the temperature falls, and the loss is diminished. Heat loss is also dependent upon the activity of the sweat glands, which cool the body by a process of evaporation. The skin, furthermore, may be considered a nervous organ, as it contains an expansion of the nervous system spread over the body. This network includes the various sensory organs and organs for touch, pressure, pain, and temperature. It is fully as sensitive to external stimuli as a photographic plate. In fact, the skin surface may be aptly likened to the broadcasting and receiving stations of the radio, for it is constantly engaged in accepting and transmitting an infinite number of impressions to the brain center, spinal cord, and body organs. The cutaneous nerve endings, in short, stand guard over most of the functions of the child's body, and they are constantly exposed to irritation by heat and cold; which impressions they convey to the vasomotor, respiratory, and cardiac centres, as well as to the muscles, so as to arouse them to a strong degree of innervation.

In infants and children, particularly in the former, the surface of the body is more sensitive than in later life, and the functioning of the skin and nerve centres is intimately related to the mental and physical activities. The surface of the child's body is closely connected reflexly and functionally with the underlying organs. This explains the powerful effect of hot and cold water applications upon certain internal organs. The skin is physiologically related to the gastric and intestinal mucous membrane and to the vasomotor nerve system. The external application of water is usually advised for three reasons; first for cleanliness, second for keeping the skin active and responsive to tonic applications of both cold and warm water, and third so that through the external administration of hot, warm, or cold water the brain, the endocrine and nervous systems, and metabolism may be improved in function.

Children who have inherited certain diatheses, potentialities for dysfunctions, or who exhibit somatic disturbances either do or do not react to hot and cold applications. The power of response also depends on the age, the differences in environment

trition, etc. It differs in boys and girls. In many young chil-en there may be found limits of reaction, a point where hot cold applications cease to act as a stimulant but do act as a pressive.[18]

Psychic influences often tend to combat beneficial measures. any incidences occur of children associating some object, und, or color which they dislike with the form or technique of e bath. This condition results in emotional outbursts of fear, like, or unhappiness and any benefits which should normally low the bath are lost.

PHYSIOLOGIC EFFECTS

Water administered externally produces a profound influence the child's organism reflexly, and eventually on metabolism. uite as much care must be exercised in selecting the right kind bath, its temperature, and adaptability as in choosing any her environmental stimulus. Results are influenced greatly by e constitution and condition of the child, and they are not alike a large series of cases. Cold or warm water applications on the in produce a stimulation of the cold and heat receptors spectively, affecting reflexly remote tissues, and resulting in eir various functional changes. The greater the difference in mperature between the water and the skin, the more intense the thermic stimulation.

The temperature of the child's skin varies somewhat in dif-rent parts of the body. The mean temperature in the healthy dividual is approximately ninety-three degrees Fahrenheit. bviously, water at this neutral temperature is felt neither as ld nor as hot and produces only slight functional changes, if y, particularly if the application is of brief duration. This utral point is naturally higher in febrile conditions than in rmal health. Water at a very high temperature, at or near e point of tolerance, has practically the same effect as has cold. is wise, therefore, not to place children in very hot baths when sedative effect is desired. The effect of water is influenced nsiderably by simultaneous mechanical stimulation, as well as the projectile force produced by showers, douches, surf bath-g, and any other form of friction. The physician has an op-rtunity to show all his knowledge and common sense in the pe of bath he selects. The more suddenly the water is admin-ered, the greater area to which it is applied, and the greater

the blood supply to the skin, are all factors in producing a more powerful stimulation.

When cold water is applied to the body surface the cutaneous blood vessels of the part treated become reflexly constricted. The blood thus pressed back from the peripheral vessels is accommodated by the deeper tissues, probably largely by the skeletal muscles. If the application is of short duration the constricted blood vessels, while still maintaining their tone, dilate immediately or very soon after the removal of the water and are refilled in excess of the normal supply with arterial blood from the deeper tissues. The result is a tonic peripheral hyperemia with an increased slackening of the blood current. This reaction, which among other things tends to modify metabolism, either increasing or lowering its rate, is also subject to the body's mechanism of adjustment. It is also a factor of great importance, because it is a criterion by which to measure the child's tolerance of the prescribed form of procedure. While much may be noted from the general appearance, a poor reaction is definitely indicated by a pale skin, an aspect of discomfort, chilliness and shivering, and decided lack of vigor. Great wisdom must be shown in advising cold applications of short or long duration, especially as the latter sometimes tend to temporarily paralyze the muscles as well as to retard the circulation of the blood.

If it is agreed that the child's heart is but a muscle, it can be more readily appreciated that the thermo-mechanical effect of water influences the heart's action. Properly selected cold or, better, cool applications to the body surface decrease the frequency of the heart beats by lengthening the time of diastole, while the tone of the muscle is exhausted. The constriction of the blood vessels must obviously bring about an increased expenditure of energy on the part of the heart's muscles. A prolonged diastole has the combined effect of resting and of exercising the heart, provided, of course, that the heart has sufficient strength to overcome the increased resistance in the peripheral vessels.

In treating an ill-conditioned child with an inherited dysfunction, the water, whether hot or cold, should be administered in the form of a local application. As a consequence of the constriction of the peripheral vessels, the blood pressure is raised momentarily but falls to a lower level soon after a cold application. Most of us remember the early spring bath in the old swimming hole. After the plunge and the return to the bank we experienced shivering and there followed many deep respirations.[19]

VASOMOTOR EFFECTS

Hydrotherapy is far more complicated and requires much more hought, research, and clinical experience in medical practice han does diathermy. Heat treatments are a matter of dosage rom the standpoint of time, kind of current, and the size of the ectrode. Ultraviolet ray treatment takes into consideration me, distance, and intensity. On the other hand, hydrothera-eutic treatments, in order to be efficacious, require wide ex-erience and careful judgment. The bath temperature for the ormal infant or child is practically fixed. Skill and experience re frequently necessary, however, when many pathologic condi-ons are present, including inherited dysfunctions, mitral dis-ase with arythmia, and certain affections showing vasomotor nactivity, so often seen in nutritional derangements.

Stimulation of the peripheral circulatory system is beneficial n certain heart conditions, and it is in the careful selection of he kind and temperature of the bath that much good may be ccomplished. In some instances, heart and circulatory disturb-nces prevent the proper balancing of metabolism. One might gically apply the term "skin heart" to the peripheral arterioles, apillaries, and other vessels, for in the rate of vascular contrac-on and dilatation there is an activity which may be likened to vigorous peristalsis or pumping action. Obviously this increase f vascular activity tends toward a smaller blood vessel caliber, nd tone is best preserved by cold or cool water applications, epending upon the child's reactions.[20]

Temperature changes in the circulatory system produced by aths are often important objectives in somatic disturbances. If, or instance, there is interference with the circulation in a peri-heral area, there is a possibility that necrosis of the surrounding ssue may extend to a considerable depth. There may be a eparation of the resulting dead tissue, leaving an ulcerated sur-ace. Obviously lesser disturbances may arise, such as an area f discoloration. Ulcerated surfaces are poorly supplied with lood, and in consequence heal slowly. The surface temperature f the area, however, may greatly modify the development of an lcer or tend to its recovery, whether superficial or deep. Sur-ounding temperature changes influence to a considerable degree he flow of blood under normal circumstances, but assume much reater importance in pathologic conditions. When the flow of lood is obstructed by a structural change in the vessel, tempera-ure changes brought about by moist or dry heat, as circum-tances indicate, will materially alter the circulation rate. In

infants and children one occasionally finds instances of an impeded circulation to a specific part which interferes with the nutrition of the surrounding areas. A careful estimate of the most beneficial temperature for the affected area is essential.

It has been shown by Goldsmith and Light that the velocity of venous blood returning from a limb depends on the balance between metabolism and the rate of blood flow, both of which are increased by a rise in temperature. At high temperatures they found the circulation rate so greatly increased that the venous blood contained large amounts of oxygen, even though the metabolic rate was also increased. However, when the circulatory system is disturbed by disease the result is problematical.

It has been determined that the temperature favorable to the activity of the circulation of a certain part of the organism varies with the individual patient. It is by the use of heat-producing methods that pain may be relieved and cyanosis overcome. When the temperature of an organic part is altered, when it rises, let us say, not only is the oxygen saturation of venous blood changed, but, at the same time, physiochemical factors are brought into play which considerably modify gas tension by altering the dissociation of oxyhemoglobin and by modifying the acid-base balance and the hydrogen-ion concentration of the blood, in consequence, as rise in temperature increases enormously both the oxygen and carbon dioxide tensions.

The effect of heat on the capillary circulation and the formation of tissue is another factor in the treatment of circulatory disorders. When heat is applied to an area, obviously the superficial capillaries and veins are dilated and through relaxation of the tone of the arterioles the blood flow is greatly increased. In cases of nutritional edema, a rise in temperature of the water treatment greatly relieves the lymphatic drainage and markedly modifies the condition. However, care must be observed and the reaction of the child watched, as regards the degree of temperature suitable, for lymphatic drainage might become obstructed, thus permitting the fluid to collect in the tissues with a resulting intensified edema which is more serious than the original condition. This obstruction might cause pressure on venous channels and interfere with the activity of the general circulation. It is of great importance to recognize the signs of edema early so that the cause which gave rise to it may be corrected quickly. According to Drury and Jones, edema is not detectable by clinical test (pitting) until a collection of blood of at least eight cubic centimeters per hundred cubic centimeters of tissue has occurred. The seriousness of an edema depends on the degree of capillary

ressure. It has been observed that if the temperature of the ibcutaneous area be raised to about forty-two degrees Centi- rade and maintained at that level for an hour or so, the capil- ries are in all probability rendered partly permeable to serum rotein and it is their loss that is the basic cause of nutritional lema. There may, however, result a slight superficial edema hich may or may not be discovered.

The temperature of the water applied to the skin either causes ipillary blockage, or the drainage varies with the rate of circu- tion through the skin. When this rate is rapid, tests may show iat a bath of forty-five degrees may be only just sufficient to iuse the necessary rise of local temperature within the child's ssues, owing to the maintenance of a lower temperature level in ie skin by the rapidly flowing blood. In another child with a ower circulation rate a bath at a temperature which does not cceed forty-two or forty-three degrees may cause a slight burn.

In the cases of slight edema, spray baths rather than tub baths ay be employed advantageously, for with the latter both veins id tissues are exposed to pressures dependent upon the depth water, and the benefits of gravity are minimized as far as the tration pressure in the capillary is concerned. Incidentally, in oderate cases of edema where it is possible to gain the child's onfidence, the use of an electrical diathermy current from a high equency machine on a condenser basis has proven of great enefit, for there is a considerable generation of heat from elec- ical energy in the deeper organs and tissues, which is distributed iroughout the body.[21]

EFFECT OF HYDROTHERAPY ON THE NERVOUS SYSTEM AND ON URINE SECRETION

Local applications of short duration, whether cold, cool, or arm, increase the sensibility of the nervous system and add to general balancing of the organism, while long continued cold warm applications lessen it. The central nervous system profoundly influenced by hydrotherapeutic measures, which is xpressed in the form of vigor and refreshment and in a feeling general well-being. Obviously the effects of cold or even cool aths on children are greatly modified by environment.

Cold applications, by raising the blood pressure, generally icrease temporarily the secretion of urine. On the other hand, ie increase of this urine secretion without a rise in blood pres- ire is produced by tepid baths (94-96° F.), if continued for one two hours.[19]

THE NATURE OF SECRETIONS

The urgent need of the many body secretions for water internally is shown in the nature of the secretory processes. The secretory apparatus consists essentially of a layer of secretory cells surrounding a central cavity into which the secretion is poured. The cells lie on a basement-membrane in close relation to the blood vessels which nourish the gland and provide it with the raw materials of its secretion. While the granules of the cells are the precursors of the actual substances of them, these substances cannot form unless they derive enough water from the intestines. The process of secretion consists of the transference of water and of certain substances dissolved in the water from the blood of the surrounding capillaries to the lumen of the acinus. Secondly, the modification of the chemical composition of this solution is brought about either by the addition to it of substances manufactured by the gland cells or by the prevention of substances in the lymph from traversing the gland-cell and reaching the lumen. Space will not permit further discussion of the necessity of water to the secretions, enzymes, and other biologic processes of the child's organism. It is well to remember that the expired and alveolar air in respiration is saturated with water vapor at body temperature.[12]

SWEAT

One of the important biologic secretions of the body, which requires water to establish its normal function, is sweat or, more politely termed, perspiration. This product of the sweat glands is more active in man in the palms of the hands and on the soles of the feet. In both adults and children there is a wide variation in the amount of sweat secreted. There is also a difference as to the location of the greatest amount of secretion. In children it is often advisable to examine hands and feet for this secretion as an aid in diagnosis. Sensible and insensible perspiration vary with climatic conditions. The drier and hotter the air, the greater the proportion. Neurotic children often suffer from disorders of sweat gland function. The reaction of sweat is acid and this is due to acid sodium phosphate. This is also true of urine. In profuse sweating the secretion usually becomes alkaline or neutral. The characteristic odor varies in different parts of the body. Sodium chloride is the salt found most abundantly in the secretion.

The sweat glands react readily to heat administration. The normal elimination of urea is lessened in nephritis and by heat, and the drinking of large quantities of water will cause a greater excretion of urea. Hot water applications, provided they produce sweating, are effective in eliminating certain poisons of the body and in treating sprains and bruises. Baths of whatever kind, if continued over too long a period and particularly if the temperature be above 96° F., tend to cause muscular, nervous, and organic fatigue.[19]

HYDROTHERAPY AS PREVENTIVE THERAPY FOR OLDER CHILDREN

The time is not far distant when the waters of the sea will be called upon more than in the past to serve as therapeutic agents. Sea water baths, carefully considered, prove more efficacious in preventing disease than in curing acute or chronic conditions. It may be timely to discuss the physiologic effects of water as a preventive of disease. These effects are substantially as follows:—

(1) An increase in elimination. The detoxication and the clearing out of waste products is definitely essential. This process can be stimulated by the action of appropriate waters and baths on the bowels and kidneys as well as on the skin.

(2) The training of the body surface responses to temperature changes. The circulation of the blood in the cutaneous area is improved and provision is made for the constant and delicate adjustments necessary to stabilize the heat regulating mechanism of the body.

(3) With an increased activity in the circulation of the blood, muscles and subcutaneous tissues are more freely irrigated and toxins and fatigue products more readily removed. These effects are further stimulated, particularly in the presence of stiffness or pain, by massage or other manipulation.

(4) Indirectly, by increasing the adaptability and elasticity of the peripheral circulation, the load on the heart is adjusted and the functional efficiency of the cardiac muscle, as well as of the entire cardio-vascular system, is improved.

(5) The delicacy of the reactions to heat, cold, and other external agencies is enhanced by suitable stimulation of the sensory nerve-endings in the skin. In addition, the general nervous tone is improved and adjustments between peripheral and splanchnic nerves are facilitated.

(6) The maintenance of an efficient blood supply is a large

factor in the nervous reactions in tissues and organs, as well as in the rapid removal of waste products.

Experience has given ample proof that this form of therapy in preventative medicine is premised on a foundation that is basically sound.

Unfortunately, some parents are more inclined to follow the dictates of fashion than adjustments to climate and weather conditions. This may easily lead to diminution of cutaneous activity, with a consequent lessening of the excretion of urea, sodium chloride, and certain unrecognized toxins. Such consequences impose extra work on the kidneys. The delicate vasomotor reactions to heat and cold also become less responsive, so that under unfavorable climatic and seasonal changes the child becomes unduly sensitive to heat and cold. These vasomotor instabilities are apt to find expression in erythromelalgia, cold, cyanosed extremities, chilblains, ischemic spasm, and a general abnormal sensitivity to cold. One is often led to believe that these manifestations may be developments of an inherited dysfunction. They are seen largely in connection with a rheumatic diathesis and yet some children suffering from a similar dysfunction show no such symptoms. It is entirely possible, however, that these sensitized subjects are victims of nutritional deficiencies and an improperly balanced metabolism. In such cases valuable aid is obtained by carefully selected therapeutic measures, for they assist materially in body-hardening. Highly specialized mineral baths and health resorts for these sensitized children are, as a rule, unnecessary and often economically impossible.[22]

INTERNAL HYDROTHERAPY

Internally, water is of enormous value, and the investigations of biophysical chemists have given us new conceptions of the nature of solutions which motivate osmotic phenomena, so essential in the balancing of metabolism. Water is a fluid in which soluble materials are dissolved. At ordinary temperatures its molecules are in constant movement, their activity heightened by an increase of the temperature until the boiling point is reached.

If most acids, bases, and salts, common table salt, for example, be dissolved in water, the solution is capable of conducting electrical currents in the child's body. These substances undergo what is called dissociation, and the simpler materials into which they are broken up in the water are called "ions." Thus, in the case of the dissolving sodium chloride, part of the molecules be-

ome dissociated into sodium ions which are charged with posiive electricity, and part into chlorine ions which are charged vith negative electricity. Since such reactions are constantly takng place in the child's organism, it causes no surprise when hysicists refer to the cells as electric batteries. The liquids of the ody contain electrolytes in solution, substances which exhibit the roperty of dissociation, and they are able to conduct electrical urrents. The living tissues of a healthy child are extremely ensitive to the nature and concentration of these ions in their nvironment.

Broadly speaking, the greater the dilution and the more nearly omplete the dissociation, the greater the organism's need of vater. Biologically this requirement is aroused by thirst, and his in turn is more pronounced by the increased sweating reulting from physical exercise. This necessity of the child's organism for water is further expressed in the functional process of osmosis. In the body are found solutions of various substances eparated from one another by a membrane. The endothelial valls of the capillaries separate the blood from the lymph, and he epithelial walls of the kidney tubules separate the blood and ymph from the urine, just as similar epithelial walls surround ll secreting glands. Then too, there is the wall of the alimentary anal which separates the digested food from the blood vessels nd lacteals. In the formation of lymph, urine, and other excretions and secretions, as well as in the absorption of food, the aws that regulate the movements of the water in the body, together with the substances which are held in solution in it, must e carefully considered. A knowledge of the secretory or selective ctivity of the living cells of which the membranes are composed s also important. The stomach absorbs a certain amount of vater and the small intestine much more; this action comprises one of the most important needs of the body for a supply of water internally. Salts and sugars when ingested in a dry concentrated mass must be diluted with water before they are absorbed. The absorption of food in the small intestine begins at he duodenum and the digestible materials have largely disappeared by the time the intestinal mass has reached the ileo-caecal valve at the beginning of the large intestine. Stagnant collections of feces in the intestines may be moved along by copious draughts of cool or cold water. The body has two channels of absorption, the blood vessels and the lymph vessels or lacteals. Proteins and carbohydrates are absorbed by the blood vessels, while fats are absorbed by the lacteals. All these various processes require water for proper functioning.[12]

Water is also necessary for many organic activities. Abstaining from fluids at meals may lead to a deficient nutrient metabolism. During the dry, hot weather, mothers often worry over the high concentration of their children's urine. This is entirely normal, for it is caused by excessive sweating which cools the body but limits the flow of urine. When there is a continuation of excessive sweating and a very limited intake of water, a precipitation of certain salts may occur and infrequently "stone" is found in the urinary passage.[12]

The drinking of water on arising in the morning and between meals flushes the stomach and intestines and makes them ready for food ingestion. It also hastens the passage of a too dry meal. A large quantity of water taken internally, in addition to cleansing the walls of the stomach and intestines, has an inhibitory action on a secondary carbohydrate fermentation in its incipiency. The flow of warm water through the stomach will stimulate the flow of hydrochloric acid and of gastric ferments. Thirst is only a natural demand for the drinking of water, and forcing a child to drink against his will causes organic disturbances. If benefit is to be derived from water there must be an adequate physiologic response on the part of the child.[23]

EFFECTS OF WATER ON THE INTESTINES

If the stomach requires water for functioning, the intestines need it still more. It may be logically inferred that about 500 cc. or more fluid contents pass the ileo-caecal valve daily in a healthy child. Nutritious substances have been absorbed by the small intestine as the food mass from the stomach passes through. Of the remainder, comprising the 500 cc. or more of substances, the large intestine absorbs about 400 cc., leaving approximately 100 cc. of feces. Naturally these figures are subject to considerable variation, not only because of the various types of children in health, but because of the many pathologic conditions in disease. Diarrhoea is only one of the many instances of the latter group. Normally, with that amount of water ingested and with a proper regulation of the child's diet, natural soft bowel movements may be expected. But here again numerous factors may intervene. The child may not be allowed to exercise freely. This prevents a natural thirst. At times there are parental restrictions and the child is not allowed to defecate when the need arises. Sometimes when meals consist entirely of dry foods, the feces are apt to become hard and dry and constipation results.

Since the mucous membrane of the large intestine produces no gestive enzymes, many preformed protein mixtures, especially hen introduced as rectal feeding, are not absorbed, as they are ot predigested. The value of substituting enemata for oral eding is open to debate. Such undigested material proves a rtile soil for the bacteria which abound in the intestine.[12]

HYDROTHERAPY IN PEDIATRICS

It has been estimated that a sick infant requires at least three unces of fluid to each pound of body weight in twenty-four ours, while a normal, active child requires much more. The egree of body temperature in fevers, with its tendency toward udden changes, is an important factor in water applications, for ne temperature of the water and the form of application are nportant requisites for successful treatment. Many forms of ater application can be carried on successfully in the home. or the ailing infant and small child a warm tub bath may be rescribed, and for the older and stronger child, a shower. Both nese methods, together with the sheet or evaporation bath, when ne fever continues and pathologic symptoms seem imminent, sually prove effective.

It is not our intention to consider the more complicated baths rescribed for serious organic disturbances such as convulsions, ollapse, etc., but to limit our discussion to the health and deelopment of normal infants and children, with the exception of nose disturbances of nutrition. Certain selective diseases adnittedly require particular forms of treatment.[24]

TECHNIQUE

Even more care and thought must be exercised in prescribing he type of bath for a child than in advising a certain form of nedicinal therapy. Attention should be focused on the heredity r on purely environmental factors. No two infants and no two hildren react in just the same manner to applications of either ot or cold water. The effects of bathing depend chiefly on the lifference between the temperature of the skin and that of the vater. Care should be taken to insure sufficient warmth for the nfant and young child in their surroundings before beginning he bath. This can be provided by having the room temperature etween 70° and 85° F., or by wrapping the child in a blanket. The temperature of a room in which a very young and delicate

infant is bathed should be between 80° and 100° F. Lower temperatures will depend upon the constitution, condition, and age of the infant.

Premature infants require very high room temperatures and very warm coverings. Great care must be taken to guard the infant against sudden or great loss of body heat after bathing. If the reaction from the bath does not immediately take place, the water is probably too cool. It is best, however, to wait a short time for a possible delayed reaction before adding warmer water. With sickly or enfeebled infants and children or those manifesting fear of the bath, it is advisable to apply the water gradually. This can be done by bathing first one limb and then another, then the back, and finally the whole trunk. With added strength and vitality, the temperature of the bath may be lowered slightly, thus increasing the child's vigor. At this time also the duration of the bath may be lengthened.

The shorter the bath period and the cooler the temperature of the water, the higher the metabolic rate. The infant graduates from the limb applications to the bath tub, and the older child goes from the bath tub to the shower. Water of any temperature or in any form cannot often be successfully administered to the spoiled, undisciplined, highly irritable, and nervous child. Indeed the effects may be unpredictable. Not only do such children display poor reactions, but there may be a tendency to spasmodic vascular and muscular contractions and to vasomotor disturbances as seen in hysteria. Likewise, reactions may be poor in diseases of the peripheral nerves, in febrile infections due to toxemias, in acute nephritis accompanied by a spasm of the renal vessels, and in other somatic conditions of anemia and chlorosis.[19]

WARM APPLICATIONS

The effects of warm water applications are contrary to those of cold. There is a general dilatation of the superficial vessels with a compensatory action from the constriction of the deeper vessels. The rate of circulation may be increased twenty-nine percent. With the heart beating more rapidly more blood is passed to the skin, thus leaving the deeper tissues none too well supplied. A mild exposure to warmth undoubtedly decreases the load on the heart, but a rise of temperature above the optimum is apt to be of more serious consequence than a fall.

Children with circulatory disorders are benefited by higher temperatures of air or baths, for through sweating they rid the

dy of an overload of blood, even though the work of the heart ay be increased temporarily. The pulse rate rises and both stolic and diastolic pressures fall, but tend to rise later, depending on the subject. A rapid rise in the bath temperature ten causes considerable discomfort, therefore the temperature ould be increased gradually. Varying with older children, the se in body temperature may induce a profound respiratory action, thus causing distinct discomfort. The blood becomes ore alkaline in character, which condition may or may not ve an injurious effect on the heart or cause a rise in systolic essure.

In spite of differences of opinion, it will be found that in rtain nutritional diseases sweating occurs just as freely in ater as in air. Indeed, in many cases sweating occurs more pidly, particularly when salt is added to the bath. An important consideration is that water is usually more readily available an heated air.

Weight is lost both through the lungs by water evaporation nd through sweating, but that lost through the lungs is unacompanied by the loss of salts, etc., while from sweating the loss nges from two hundred to one thousand grams per hour. The ss of weight by respiratory metabolism is even less, for it rarely mounts to more than from one to three grams an hour.

One advantage of warm baths is the temporary increase in e rate of urine formation. This effect is especially useful in onnection with the occasional anurias following metabolic deangements. Urine formation is biologic in the normal child ut is of even greater significance in the abnormal child. Such erapeutic measures should be advised as will not cause too reat a strain on the kidneys. The most serious objection to ery warm baths is found in the case of patients suffering from irculatory disorders. The profound vascular dilatation produced by these baths causes considerable strain on the circulaion, particularly since the marked dilatation of the large veins nay diminish the return of the blood to the heart. With sweatng and a consequent loss of fluid, diminution in blood volume nay occur, which while being instrumental in the absorption of dema fluid, increases interference with the venous return to he heart. This may lead to symptoms similar to shock, with estlessness as a prominent feature. In the bath tub such changes are less likely to give serious results, as the subject is lying down with head held in a raised position, for the accumulation of blood by gravity is prevented, and the water pressure counteracts, to some extent, the extreme dilatation caused by the ab-

sorption of blood needed for other areas by the superficial veins.

A really dangerous feature of bathing is the rapid rise of body temperature from a too hot bath. To counteract this danger, when very warm baths are indicated, the temperature of the water should range from 99° F. to 101° F. or less. The water should be agitated constantly to give an even temperature.[21]

HOT APPLICATIONS

The application of intense heat brings about a marked dilation of the peripheral blood vessels with a resulting hyperemia that is tonic in character because the contractile elements of the blood vessels and the tissues in which they are imbedded relax. The hyperemia produced by heat is more pronounced than that produced by cold, and this knowledge is of importance in treating a typical form of disease. Heat in the form of water or sunshine applied to the whole body surface increases the frequency of the pulse and lowers the tone of the heart muscle, a vital necessity in certain heart dysfunctions intensified by excessive exercise or from emotional excitement. After a brief initial rise the blood pressure is lowered, but if the temperature of the application is markedly increased, perhaps to 104° F., the pressure remains high or may even go higher. In all treatments it is advisable to begin with warm and not with hot applications, since the temperature may be increased as desired.[19]

BATHS

Among the types of baths in use today are sheet baths, dripsheet baths, packs, and three-quarter packs. These uncommon forms are very essential in emergencies but in conditions resulting from faulty nutrition they are rarely necessary. The eating of olives is probably an acquired taste, so perhaps is the bath. If the strong, active child acquires a taste for bathing at an early age he will continue to enjoy a moderate cold tub or spray bath of one half to two minutes duration, followed by vigorous friction. In febrile disease with rising temperatures, such as those often seen in typhoid fever, cold or cool baths may occasionally be employed with benefit. Fortunately the Brand type of bath is no longer advised, for not only are its principles unbiologic but it is unnecessarily harsh. There is often the tendency to try to lower high temperatures in fevers suddenly without inquiring sufficiently into the cause of the fever, for, generally speaking, the fever is reduced when the cause is removed. In febrile conditions it is well before beginning a bath to consider the general tone

f the heart and peripheral blood vessels. When the patient's ondition cannot at once be accurately ascertained, it may be dvisable to place him in water of a rather high temperature for short time and then gradually lower the temperature to one rom which he reacts. When the condition has returned to nor- nal, cooler baths of longer duration may be substituted.

Whether the child is ill or well, no form of bathing is com- lete without a superficial body massage, either during the bath r after, during the drying of the skin. These measures apply nostly to infants.

In cases of extreme nervous irritability, a special type of bath nay be used. While the patient is still in the tub, the bed is rst spread with a warm woolen blanket, on top of which is pread a warm sheet. The patient before being dried is quickly laced in bed. Both sheet and blanket are wrapped snugly round him. When indicated, one or more additional blankets nay be used. The combination of moisture and body heat very oon creates a vaporous layer next to the skin which rarely fails o soothe the peripheral nerves.[19]

TEPID BATHS

With some apparently strong and healthy children an in- igorating reaction from the cool bath does not take place and t is then advisable to substitute the tepid bath. Tepid baths ave a temperature of between 94° and 96° F., and usually should ast from fifteen minutes to one hour in a room temperature of etween 75° and 85° F. After a tepid bath the sensitized patient, articularly, is wrapped in a warm dry sheet and gently dried by ong sweeping movements of the hand over the sheet. After eing dried he is placed in a bed heated with hot bricks, water ottles, or electric pads.

A rather long continued contact of the skin with tepid water esults in a flow of blood to the surface of the body, with a orresponding depletion of blood vessels in the deeper recesses. This is particularly marked in the intracranial blood vessels. The elimination of the blood supply in the deeper vessels, to- gether with the effect of the bath on the cutaneous nerve endings, roduces a sedative effect. This effect is beneficial in certain types of nervous irritability, insomnia, foundational neuroses, and bscure organic maladjustments, as well as in spastic conditions of the central nervous system. The patient's fear may minimize he satisfactory effects of the bath, but with this fear dispelled, ubsequent baths should prove highly efficacious.

Tepid baths of longer or shorter duration not only stimulate diuresis in renal insufficiency but promote the elimination of sodium chloride and other nitrogenous substances. In many cases tepid baths are more effective than other diaphoretic measures. In very young infants suffering from gastro-intestinal disturbances attended with fever, tepid baths of ten minutes duration will usually ease the pain, lower the temperature, moderate the emotional state, and produce sleep. In earlier days when bacteria laden milk was given to infants and children, the "continuous bath" was a mainstay in the treatment of such disorders. However, at the present time with greatly improved sanitary, hygienic, and prophylactic measures, it is rarely necessary. The continuous bath comprises a large tub over which is suspended, in hammock-like fashion, a strong sheet. Modern equipment includes a mixing chamber with a thermometer, thermostatic valve, and pressure gauge. The apparatus is connected with the supply lines, and a uniform temperature is maintained throughout the bath. After the tub is filled with water at a temperature of between 94° and 99° F., the child is placed supine on the suspended sheet with his head resting on an inflated rubber pillow. The temperature should be uniform through the period of the bath, a point to be emphasized. The first baths are usually of one hour's duration and the time is gradually increased for subsequent applications.

The continuous bath has the same effect on the blood distribution as that produced by the tepid bath, except that it is more pronounced. A very sedative effect on the whole nervous system of the child may be produced from long continued depletion of the blood in the arterial vessels. The increased rate of the flow of blood in the vessels tends to a more rapid repair of destroyed tissue. This increased rate is effective when intestinal putrefaction is present. In older children these continuous baths are sometimes indicated in mild mental disturbances, spasmodic conditions, extensive burns, urticaria, small ulcerations, various types of dietetic disturbances, infections of long duration, insect bites, and also in the pains, aches, and stiffness in muscles.[19]

HOT BATHS

Another form of bath seldom used and therefore of slight concern is the hot bath. The temperature of such a bath ranges from 100° to 110° F., and its duration should be from ten to twenty minutes, never longer. It is well to begin with a temperature of 96° to 98° F., and then increase it until the desired effects are

chieved. The vitality of the child is slightly lowered, but the etabolic rate is increased. It is sometimes advisable after the ath to rub cool water over the skin surface.

In older children, when profuse sweating is desired, the patient put to bed for a short time and blanketed warmly for as long s the sweating is considered necessary, then cooled off gradually efore arising.

These baths may be used to advantage in exogenous and endo- enous intoxications and in many kinds of poisoning, for toxic aterial is eliminated in the feces, urine, or through the skin.[19]

DOUCHE BATHS

For older children in good health the best form of hydro- erapy is the douche bath or, as it is better known, the spray. he fan douche is by far the best. Spread out in the shape of fan, the volume of water has a less powerful impact on the kin than with the solid stream of water. The "jet" douche ometimes so frightens the child that no benefit is derived from . With the fan douche the temperature may be altered at will, arting the bath perhaps with warm water and finishing with old. Usually such baths are of short duration. There is an in- reased invigoration from the mechanical stimulation which is ot obtainable by the use of the tub.

The Scotch douche bath is especially beneficial in conditions f insufficient muscular control. It is helpful, too, in cases of luggish circulation. Applied to the chest, this form of bath tends o soften viscous mucus in simple catarrhal disturbances, facili- ating expectoration. Directed at the abdomen, the bath is often ndicated in moderate venous stasis of the abdominal organs, in yperemia of the liver, in acute catarrhal jaundice, and in motor nsufficiency of the stomach and intestines.[19]

THE DRYING OF THE SKIN

After the bath, the drying of the skin is a very important con- ideration. The skin should be dried thoroughly and then ubbed briskly and gently with a soft woolen blanket or with a oft cotton towel. For older children, linen is preferred, since t readily absorbs water, but material of coarser texture provides more vigorous stimulation. After the skin is thoroughly dry, gentle superficial massage may be given advantageously.

If the bath has been cool or cold, the patient should be guarded against a sudden chilling of the skin or even overheat-

ing. Whether in the bathroom, bedroom, or in the open, the clothing and blankets should be light and loose enough to admit air to the skin surface, thus preventing the danger of copious perspiration and of catching cold from the relaxed and dilated cutaneous vessels, following the bath. During bathing no water should come in contact with the head of the patient, the bathing period being no time for a shampoo. To prevent water from splashing on the head, a rubber cap should be worn, but it should not fit too tightly.[19]

CLOTHING

From time immemorial the clothing of children has simulated that of their elders. The cave man wrapped his family in the skins of wild beasts. Greek and Roman children were clad in tunics and cloaks. Among the well to do the tunic was often decorated with designs of animals, forests, mountains, or huntsmen, and many were designed in elaborate colors. These modes held their place with modifications for many generations. During the 16th, 17th, 18th, and 19th centuries, changes in children's clothing were marked. In the beginning, tight hose which enveloped the legs became the fashion with boys, the horned mitre, and turban became the head dress, and pointed shoes were worn. Soon the hose were divided into stockings and for boys the sleeves of coats were slit, while the girls wore ample shirts often richly embroidered in bright colors. The frill at the neck developed into the pleated ruff and the broad uppers of the shoes were slashed. Later the girls wore pantelettes and the boys short, skin tight trousers. Many other modifications took place. While children's clothing at the present time is far less artistic than that of former years, it is much more suitable and practical.[25]

THERAPEUTIC VALUE OF CLOTHING

Suitable clothing is important for the maintenance of health and vigor. In summer, improper clothing may become a sweat box, and in winter an ice box. In a sense, clothing may be likened to an artificial climate. If properly chosen, it tends to keep the skin at an even temperature. An important result of its misuse is the overchilling of the skin, which may eventually lead to respiratory affections.

"Keep the feet warm and the head cool," is not a bad admonition. Chilling of the feet results in a fall in surface tem-

ature and albumin in the urine, indicating a disturbance the organism. If a child's feet remain wet for any length of ne the temperature of the hand is changed. Also there may pear symptoms of rhinitis, accompanied by shivering, sneezing, d body fatigue. These symptoms disappear miraculously when d, wet shoes and stockings are replaced with dry, warm ones. The protection and suitability of clothing are dependent gely on its texture and thickness and on the ease with which can pass through it. Many children are sensitive to seasonal d climatic changes and may acquire respiratory affections. For s reason the choosing of clothing is an important responsibility d is by no means simple. Knitted wool, cotton, silk, or artificial rics suitable for one child are not suitable for another. A child ing in a certain climate, accustomed to garments of a specific nd, texture, and porosity may become ill if a radical change is ade. This applies especially to undergarments. Highly sensie children and those inheriting a rheumatic diathesis should protected at night from a loss of body heat by light woolen ankets, even though the room is warm. Clothing and housing e interdependent, for with proper coverings, heat, and ventilan, an artificial climate may be created. In the heat of summer is obvious that susceptible children do not require the exting care demanded during the winter months, but even in rm weather clothing must be adapted to the temperature.[26]

CIRCULATORY CHANGES INFLUENCED BY CLOTHING

Circulatory changes occur within the child's body from the ects upon the skin surface of the weight, texture, and color of s clothing, and present a picture somewhat similar to that ought about by hydrotherapy. Clothing for infants and chilen must be chosen from the standpoints of age, good taste, nsitization, seasonal and climatic changes, and nutrition. Thus link may be added to the chain of environmental factors best ted to the child's welfare. In choosing fabrics the following oints should be considered:—

(1) Heat retention
(2) Degree of moisture absorption
(3) Porosity
(4) Skin irritations and allergies
(5) Laundering and durability
(6) Relative cost

Snelling and Brown have made a careful study of the various woolens, cottons, silks, rayons, and their admixtures. Diaper materials are canton flannel, flannelet, bird's-eye, and knitted goods.[27] The basic materials from which all clothing is made are plant derivatives such as cotton, linen, hemp, and some grasses, and animal sources such as silk and wool.

Clothing prevents the loss of heat from the child's body; the less clothing, the less loss. This is an important point with premature infants or older children suffering from nutritional disorders.[28]

CLOTHING FABRICS IN GENERAL

Before deciding upon a suitable fabric, the structure of several materials should be investigated. Wool, being an animal fibre, is nature's natural protection against climatic and seasonal changes. It can be advantageously used in winter and summer, in high and low altitudes, and especially in those regions near the sea where sudden barometric changes are frequent. It may be considered almost an appendage of the skin, for wool is formed of a keratin-like substance. Under the microscope its fibres appear round, kinky, and covered with scales. Woolen threads are elastic and will stretch considerably without breaking, after which they return to their former length. Beside this elasticity, the threads have a tendency to be stiff and springy in a transverse direction. In the process of spinning worsted, the short fibres are combed out, then drawn and redrawn, doubled and redoubled, until the fibres are all parallel, after which the yarn is spun. It is the preparation of the yarn that makes for finer grades of woolens, so adaptable for infants' clothing.

The cotton fibres from the seed pod of the cotton plant are vegetable in nature. They are composed of cellulose and have a fine, soft texture. Under the microscope they look like curled threads with thick edges and flat centres. Cotton and woolen yarns are spun in a similar way. Both fabrics possess about the same strength, but the cotton is less harsh and has not the same tendency to irritate the skin. Cotton yarn lacks elasticity. Cotton fibres are free from the tiny scales which in wool may act as irritants.

Rayon is made from plant fibres that have been chemically treated. When examined microscopically they are found to be smooth, lustrous, and quite round. As yarn, rayon looks like shiny, smooth, twisted cord, with some threads extending out

ond the general mass. As wearing apparel rayon products delightfully smooth and non-irritating.

To avoid the possibility of chafing from woolen clothing, par- ularly undergarments, wool fabric which is cotton faced is to preferred. This two-faced material has distinct advantages, only in preventing a skin sensitization from wool, but also m that caused by somatic disturbances.[27]

THE SELECTION OF CLOTHING

Extreme care, therefore, must be observed in the selection of e infant's clothing, especially underclothing. Even greater pre- utions must be taken with premature infants. Unsuitable un- rgarments may cause skin affections, respiratory conditions, rvous irritations, digestive ailments, eczemas, colds, headaches, lic, and asthmatic attacks. Soft cotton, silk, wool, or their mixtures are found to be the most desirable fabrics. The pre- iling mode may influence the style and composition of a gar- ent, which may or may not be hygienic or therapeutic. For stance, infants' shirts are either single or double breasted, and e type best suited to the child should be chosen.

The question often arises as to whether buttons or ties should used in drawing garments together. Ties would seem to be eferable, as the soft knots do not press into the delicate flesh do the buttons. Some mothers favor slips, while others do not. here is also a wide diversity of opinion as to the use of bands. he answer would seem to hinge on the constitution and en- ronment of the infant. Knitted bands are deservedly popular, ut some parents prefer those of birds-eye, while others choose e taped variety. The diaper may be a square fold with round orners or of the old-fashioned triangular shape; both forms opular.[29]

STRENGTH AND DURABILITY OF FABRICS

Cotton and wool have about the same strength, but wool is e more durable when laundered properly. Cotton fibres be- ome brittle with use. Woolen garments are even of greater isadvantage, in that they shrink, although shrinkage is partly vercome by the use of an admixture. A cotton warp tends to eep woolen yarn in shape.

Rayon, contrary to general belief, is a strong, wiry material

and is durable, provided it is not stretched too much when wet. In knitted wear, if a thread is broken, a run results. In diaper material, the modern mother seems to place durability above other qualities. Both flannelet and canton flannel lose their nap when subjected to hard washing, which affects their absorptive value. Generally speaking, knitted garments are the best, most economical, and trustworthy.

It is always interesting to notice what women shoppers buy in the infants' and children's wear department. Plain cotton garments are the cheapest and prices range upward from cotton to cotton with rayon, to cotton with wool, wool with rayon, to pure wool, and lastly to silk with wool. A combination of rayon and wool seems popular among the more well-to-do. Flannelet night gowns are in great demand for infants and delicate children, for the price of the pure wool garment is often beyond the purse of many. Light woolen garments are used with various kinds of night gowns. Bird's-eye is much favored for diapers, being much less expensive than the knitted variety.[27]

POROSITY

Air must penetrate clothing to render it suitable for wear. It has been established that 935 liters of air should flow through a light summer suit in the course of an hour. Normally the preservation of body heat bears a direct relationship to the ease with which the air reaches the skin protected by clothing, but dampness of the surrounding air and moisture in the clothing have a tendency to increase the loss of body heat. Fabrics have different degrees of moisture absorption which may double their weight. Cottons and woolens, when wet, become three times as heavy. Mixed woolen goods are preferable, since they allow the air to reach freely the body surface. With them the capillary absorptive power of clothing is reached, while the free penetration of air is but slightly decreased.

For infants and young children especially, clothing should be such that air not only reaches the body surface but remains there, in order to provide a dry layer next the skin. If the release of moisture from the body is hampered by clothing the surrounding air layer on the skin surface becomes saturated and clammy. The moisture content, instead of being a normal thirty percent, is increased to fifty-five or to sixty-five percent. This naturally affects the child's well being. To remedy this condition it is advisable to use tricot—a woolen-yarn material, or goods made of

oth, fine cotton and linen mixture, which can be conveniently le into sleeping garments or for wearing in the nursery.

'he clothing worn by older boys is usually much too heavy, ecially when contrasted with that worn by girls. One might ost say that boys play in a tropical climate while girls ren in one of high altitude. Cotton and linen materials tend absorb perspiration but knitted woolen garments aid in reing moisture from the skin surface to the surrounding iosphere. It can be seen, therefore, that for a sensitive child olen garments are preferable even in the summer months. At time should the clothing be too warm. Of late years Jaeger lerclothing has been prescribed for year-round use in a weight able to the season and to the individual child. In cold ather warm outer garments may be worn out-of-doors, but uld be removed on entering overheated houses. The weight of undergarments should provide the skin with a temperature responding to that of the room.[28]

The permeability of clothing to air may be expressed in the mber of seconds which are necessary to propel one cubic centiter of air at a pressure of 0.42 millimeters over a one-cubictimeter surface of cloth of one centimeter thickness. The ie, of course, differs in the various fabrics and may be expressed seconds:—[28]

Closely woven cotton cloth	76	seconds
Knitted wool	6	"
Coarse woolen cloth	3	"
Knitted cotton	1	"

Children's clothing must be porous, not only to air but also light. By simple experiments at home one may determine the ative porosity of fabrics. If a piece of photographic paper is t inside a silk stocking which is then laid in the sunlight for minute or two, a dark coloration will show on the paper. If piece of the same paper is placed under a man's straw hat and t in the sun's rays for ten minutes, the paper will be blackened spots corresponding to the tiny spaces between the straw. If ain a piece of this paper is placed under a man's shirt with his at over it, no discoloration will be evident, but should the an remove his coat and remain in the sunlight, a discoloration ll be noted. Sunlight should pass readily through the linen esh of men's undergarments. A man's suit of woolen homespun d his golf stockings will allow light to pass through them beuse of their loose weave.[28]

RAPIDITY OF WATER ABSORPTION BY FABRICS

It is not only interesting but essential to know the time taken by different fabrics for absorbing moisture. The rapidity of absorption may be tested by placing a drop of water on each of several different materials and observing how long it takes the water to disappear. Diaper materials of knitted bleached cotton and bird's-eye will show almost immediate absorption. It takes some time for water to penetrate flannelet, while canton flannel shows almost no absorptive power. Rayon and bleached cotton show a quick disappearance of water, but mercerized cotton gives only fairly rapid action. With a very few clothing materials, no absorption of water is noted.[27]

HEAT CONDUCTION

The heat conduction of different materials may be expressed as follows:—

	Percent
Knitted wool	100
Wool	68
Linen	119
Smooth linen	133
Coarse cotton cloth	76

Heat conduction of wet clothing is three times that of dry. In the temperate zone over a large part of the year body heat is generally higher than the outside air, but it is immediately lowered when one steps from the warmth of a room to lower temperature. To meet these changes it is advisable to wear heavy, dark clothing, not too porous, for winter, and in warm weather to use light weight and light colored clothing. Lighter clothing admits air more readily to the body surface and thus aids the evaporation of moisture.[28]

RETENTION OF HEAT

The ability of a fabric to retain heat was investigated by Snelling and Brown in two ways:—

The first method was to cover liter bottles with the fabric. The bottles were filled with hot water and the cork and thermometer replaced; the temperature was taken and recorded in one hour. The fabric covering the bottle in which there should

he least fall in temperature was obviously the best retainer. a control, the temperature was recorded in an uncovered tle.

n the second method, the bottles were rinsed three times with water in order to heat the glass and to overcome the initial rp fall in temperature due to the cold glass. The thermome- were at the same level, the water was not agitated, and the tles were placed two feet apart to overcome radiation from to another. This experiment was carried out in three groups, the results are shown in tables 1, 2, and 3.

TABLE 1

AT RETENTION; FALL IN TEMPERATURE OF BOTTLES COVERED BY RIBBED KNIT, FLEECE-LINED, AND RAYON FABRICS FOR ONE HOUR

Fabric	Average Fall (Centigrade)	Percent Fall	Calories Lost	Calories Retained
oed knit:—				
'ool.	11.9	100	11,900	58,100
'ool and cotton (equal parts)	13.0	108.3	13,000	57,000
nbleached cotton	13.7	114.9	13,700	56,300
lercerized cotton	14.8	123.4	14,800	55,200
ece-lined	13.1	110.4	13,100	56,900
on	15.8	132.0	15,800	54,200
itrol	17.9	149.0	17,900	52,000

TABLE 2

EAT RETENTION; FALL IN TEMPERATURE OF BOTTLES COVERED BY FLAT STITCH KNIT FABRICS AND DIAPER MATERIALS FOR ONE HOUR

Fabric	Average Fall Centigrade	Percent Fall	Calories Lost	Calories Retained
at stitch knitted:—				
Wool	10.2	100	10,200	59,800
Bleached cotton	13.6	129	13,600	56,400
eece	12.8	120.6	12,800	57,200
nton flannel	10.7	106	10,700	59,300
annelet	12.3	120	12,300	57,700
rd's-eye	12.8	125	12,800	57,200

TABLE 3

HEAT RETENTION; FALL IN TEMPERATURE IN BOTTLES COVERED FOR ONE HOUR BY RIBBED KNIT FABRICS, WOOL, WOOL AND COTTON COMBINED BY THE USUAL METHOD, AND WOOL AND COTTON COMBINED BY TWO LAYER METHOD

Fabric	Average Fall Centigrade	Percent Fall	Calories Lost	Calories Retained
Wool	11.0	100	11,000	59,000
Wool and cotton (usual)	11.9	108.1	11,900	58,100
Two layer*				
Number 5	11.4	103.6	11,400	58,600
Number 2	12.3	111.1	12,300	57,700
Number 1	12.2	111.0	12,200	57,800

* Two layer fabrics all approximately 50 percent cotton and wool.

Other observations on heat retention were made by using a human subject. A sensitive electrical skin thermometer was employed with which very delicate readings could be made. A sleeve of the fabric to be tested was placed on one arm and one of another fabric on the other. After five minutes readings were taken of each arm. The results of this work are shown in table 4.

TABLE 4

AVERAGE TEMPERATURE OF SKIN OF THIRTY CONSECUTIVE DETERMINATIONS UNDER EACH FABRIC USED ON THE ARM AS A SLEEVE

Fabric	Average Temperature of Arm (Centigrade)
Wool (flat stitch)	35.25
Wool (ribbed)	35.15
Wool and cotton	34.97
Unbleached cotton	34.75
Fleece-lined cotton	34.50
Bleached cotton	34.50
Mercerized cotton	34.43
Rayon	34.08

To determine the total absorption per gram of fabric, pieces the size were weighed and then immersed in a beaker with a termined quantity of water for five minutes. Computations ere made, and the results are shown in table 5:—

TABLE 5

HE NUMBER OF CUBIC CENTIMETERS ABSORBED PER GRAM OF FABRIC AFTER FIVE MINUTES' SUBMERSION IN WATER; AVERAGE OF FIVE DETERMINATIONS

Fabric	Cubic Centimeters Absorbed
(a) Diaper materials	
Flannelet	3.73
Bleached cotton (knotted)	2.89
Bird's-eye	2.3
Canton flannel	1.25
(b) Underwear fabrics	
Rayon	1.85
Fleece	1.32
Bleached cotton	2.89
Mercerized bleached cotton	2.18
Unbleached cotton	0.59
Wool and cotton	0.95
Wool	0.85
Two layer fabrics	
Number 5	2.0
Number 2	1.7
Number 1	1.3

ABSORPTION OF HEAT RAYS

If a hypothetical figure be set at 100 for white fabrics, the bsorptive power of the different colored materials are as folows:—

Light yellow	102
Dark yellow	140
Light green	152
Red	162
Light gray	198
Black	208

Light colored materials, particularly white, obstruct the heat rays best.[28]

IRRADIATION OF THE SKIN THROUGH FABRICS

How much the child's skin is affected by irradiation through his clothing may be seen in the following tabulation.

A skin temperature of 15 degrees C. and a percentage radiation factor of 100 is assumed.

	Percent
Through wool shirt	73
Through wool and linen shirt	60
Through wool and linen shirt & vest	40
As above with coat added	33

With a child fully clothed in the winter, the radiation of the skin is one third of that experienced in the summer.[28]

PENETRATION POWER OF RADIATION

A certain amount of experimentation has been done in connection with the power of the light rays to penetrate fabrics. Comparisons were made between cotton, linen, wool, and silk as to the influence of their fibre and coloring on the germicidal action of light. Bacterial action of light is confined to the ultra-violet region of the spectrum, beginning at 350 mu. and extending with increasing intensity to the shortest wave-length measurable with the spectrograph, or 185 mu. Incidentally, Coblentz and Fulton have found that the lethal effect of the light rays for bacillus coli extended from 296 to 220 mu.

Luckiesh states that in general substances are increasingly opaque to ultra-violet radiations as the wave-length of the radiations decreases. He compared the bacterial action of ultra-violet light with the chemical action of ultra-violet rays, and found that rays passing through a viscous screen have 300 times as much bacterial power as those through glass, but only 1.6 to 5 times greater chemical action. Radiation passing through a quartz screen, on the other hand, was found to be 1,000 times greater than the standard, but the chemical action was only four to six times greater.

The United States Bureau of Standards has published its findings on the ultra-violet ray transmission by fabrics and shown that, after eliminating the light transmitted through spaces between threads, transmission was estimated for white or uncolored threads as follows:—

Cotton varies from 17 to 20 percent
Silk varies from 14 to 18 percent
Wool varies from 5 to 15 percent

t has been claimed that a slight coloring of a fabric greatly reases the transmission of the ultra-violet rays; penetration ough the thread, especially when dyed, being 5 to 10 percent. e thread usually occupies 95-99 percent of the total space of fabric, so that an increased transparency to ultra-violet radians is obtained in garments of open weave.

Hess and Weinstock have demonstrated that the rays of the do not have to strike the surface of the skin directly to arouse neficial effects. Consequently the infant is best placed near sun's rays but in the shade. Clothing for infants and children ould be chosen from the standpoint of filter material, the ering action depending upon its texture and thickness. Black thing absorbs many more of the effective ultra-violet rays than ite materials.

A study was undertaken to determine the protection afforded skin by textile fibers against sunburn. Results showed that otection from sunburn depends largely on the percentage of erspace in the fabric. It was found, too, that vegetable fibres nsmit some of the burning rays.

Screening tests were made of these fabrics by the use of photomy. The spectrographs of the fabrics used showed that none them absorbed any of the rays of the spectrum the range of ich was between the limits of 500 and 250 microns. Dozier and organ made a study of the antirachitic potency of irradiated ttonseed where clothing materials were used as filters for the ys. At the end of an eight-day experiment using antirachitic ys, they concluded that baby flannel, pongee, and crepe de ine filter out the ultra-violet radiations which are antirachitlly potent. The small amount of interspace in the baby nnel and large percentage of ash in the silk materials may ve influenced this result. Further, it was found that artificial k and cotton materials transmit the rays which are effective healing rickets. These materials have the largest interspace d the smallest percentage of ash.

Bacteria are extremely difficult to remove from fabrics, since ey are held by physical force. Large numbers of them get into brics during the modern processes of mechanical laundering. ten-minute exposure to ultra-violet rays has a more effective rmicidal action on colonies of bacteria on white cotton, linen, d silk materials than on the organisms in woolen goods with e same weave. The ultra-violet rays are less effective on black aterials. It is conceivable that respiratory and pulmonary disases are due to these bacteria-laden clothes. The germicidal ction of light seems to be greatest through silk and linen and

less effective through cotton wool. The kind of material, the manner in which it is woven, and the easy access of the ultra-violet rays, are more important factors than color.[30]

FABRICS AND BACTERIA

Unfortunately very little experimental work has been done with fabrics as filters for ultra-violet rays. It is not hard to realize that enormous profit might be derived from such experimentation. It is important to appreciate the protective action of some colored materials against bacteria, as for instance black and white. This action occurs when the light rays penetrate clothing or other materials inoculated with bacteria. Rough, porous fabrics attract bacteria, and they cling to their surface.[28]

SEX ATTRACTION AND CLOTHING

Anyone who even casually studies the behavior of children finds his curiosity aroused when he notes their attitude toward dress. The parent's choice of clothing may be wholly scientific and practical as to fitness for climate, season, and skin sensitiveness, but will that selection suit the child's taste? His idea may be completely different, especially since it will be based on color rather than on suitability. Indeed many parents should change their dogmatic insistence upon the styles and types of clothing which they consider best and proper, in favor of newer modes and materials, equally practical, comfortable, and tasteful. Professor Heinig believes that unattractive and unsuitable clothing is to blame for many inferiority complexes, for whining, irritable, and unsocial children, and also for poor posture and other signs of maladjustments in childhood.

Realizing that the child's independence is dear to him, the psychologic effects of clothing should receive fuller consideration. The fact cannot be overstressed that if from earliest childhood the child is made to feel that his clothes are the result of his own selection, beneficial psychologic reactions on metabolism will be brought about. Apparently inconsequentials such as drooping shoulder straps, a too tight waist band, missing buttons, an ill-fitting dress or coat, and the wrong size shoes have unfortunate and far reaching reactions. An unseasonable hat, a disliked fabric, an old-fashioned style, and a hated color may make a child an object of derision to his school mates to such an extent that the effects may develop an inferiority complex.[31]

In many cases, admittedly, the economic factor must be care-

y considered when advising the child in the selection of able colors and fabrics. Sex, age, and environment also uence the choice of clothing.

Iacauley has made a detailed study of the psychologic aspects ch make for the attractiveness of colors in clothing for chiln. She believes that young girls choose a single brilliant color clothing while those of more advanced years are attracted by or combinations. Girls from seven to nine generally choose a gle bright color, usually blue, pink, red, or yellow, in the er named. Girls between ten and twelve tend to consider or combinations and patterned goods. After twelve years of girls prefer colors of a pale or light hue, and then begin to ose greens, greys, browns, and even black. Among boys in eral, there is a certain conservativeness, but younger children e certain definite leanings toward particular colors. The same hor observes that as both boys and girls become older there often a preference for a specific design rather than an inence upon a prevailing mode. Sometimes the ornateness of a ment appeals without regard to its suitability.

Ve have noticed that as children approach puberty there is endency to consider both fashion and suitability. The girls ct a rich material that is currently fashionable, the boys fer plain and conservative material but are rather partial to remes in cut and trimmings. One often hears young people ak of their "Sunday clothes;" in girls this applies to a silk velvet dress or coat, while the boys probably refer to flannel users and fancy socks. As parents watch and better underhd their children they realize that forcing a mode, color, or ric in wearing apparel on them has a tendency to restrict ural impulses.

Between the ages of thirteen and sixteen, among children re carefully reared, there comes a period of extreme modesty dress and behaviorism, and inclination even to prudishness. It o this stage of youth that the poet loves to address his verses. the girl there appears a beautiful picture of blossoming sex. ite unconsciously, perhaps, her main desire is to be very ractive to boys. Her thoughts dwell on the opposite sex and is ever anxious to have clothes, hair, eyebrows, complexion, d figure as attractive as possible. The flight of time however not dimmed our memory of the adolescent youth who, with dish hat, carefully tailored suit, stylish shirt and collar, bright and sport shoes, and a persuasive manner, went forth to find proval among the fair sex.

Contrary to long-established opinion, the desire or sex urge

of young girls for the companionship of the opposite sex is much stronger than in boys. This biologic urge in girls to make themselves attractive in the eyes of their male friends is accentuated by their alluring clothes or repressed by their unattractiveness. The sexual appeal of girls brings about a psycho-sexual reaction in boys. Both sexes in consequence have a heightened metabolism rate.

Just prior to that revolutionary, unstable period of puberty, there are found in many cases most extreme barbaric tastes and desires, as well as a tendency to unruly behavior. Many young girls whose thoughts are influenced by their reading and by persuasive and exaggerated motion pictures speak of dress materials of georgette, satin, silk, and velvet which they would like made into gorgeous gowns with low cut or no backs, and no sleeves. They also vision diamonds, rubies, emeralds, and sapphires with which to bedeck themselves. Boys' energy assumes a different outlet and they prefer soldier and sailor costumes and a chance to dress up on special occasions in the grotesque garments of the clown or harlequin.

It is always a depressing experience to work among the children of the poor in the city slums. Their miserable condition is made even more disheartening by their old, ill-fitting, ill-matched, and uncouth clothing. Other children especially to be pitied because of their clothing are the little ones in orphanages and other institutions where severe, unattractive uniforms are equally prescribed for all. In one sad instance in our experience such a child from an institution was caught pilfering a pretty scarf.

The adolescent child's nature is often perverse, especially as to his clothing, and his parents' most painstaking efforts to please him are met with whines and complaints. Such a child will if possible destroy a garment or a shoe to avoid wearing it.

No pediatrician connected with a large city clinic has missed the sight of an infant of foreign-born parents being unwrapped from layer after layer of heavy material before an examination could be made. Their mothers are convinced that their offspring will "take cold" if lighter clad. In the average European peasant home there are no adequate heating facilities. There is in consequence a great heat loss from a baby's body, with subsequent insufficient restitution, from faulty nutrition.

In general, children dislike any sort of clothing that causes a pressure on the body or which is stiff and unyielding, such as tight sleeves, tight waists, stiff collars, partly outgrown trousers, coats, and sweaters, and tight hat bands. Unhappy, too, is the

ld needlessly compelled to wear heavy woolen underwear into late spring to prevent the chilling of the body. Woolen lergarments at this period, acted upon by body heat and isture, become intensely irritating to a sensitive skin. Beside itching, there may result simple eczemas, and the scratching, ich only adds to the discomfort, may produce infection.[32]

THE LAUNDRY

No matter how much thought and wisdom have gone into the rchase of a garment, its serviceability and the quality of its ric may be ruined in the laundry, or else so injured as to ke it irritating to the infant's delicate skin. Woolen garments difficult to "wash," particularly because of shrinkage. This d not occur, however, for garments from reliable manufac-ers usually are preshrunk. Garments should be put to soak a short time in tepid suds, then rinsed thoroughly in water the same temperature to prevent shrinkage. There should be rubbing with strong, alkali soaps. Bleaching powders will n the quality of the fabric.

Garments made of cotton or of many other materials will with-nd boiling, but strong soaps and powders should never be d, in their laundering. Rayon must be carefully handled, for fabric has a tendency to be weakened by wetting. Snelling l Brown submitted test fabrics to an ordinary laundry process. ey found that the ribbed-knit cotton garments stretched from e-third to one-half beyond their original size. Fleece, canton nnel, and flannelet lost a large amount of fuzz. The woolens, ons, and bird's-eye were practically unchanged.[27]

CLIMATE

A sudden descent in a plane from a height of 10,000 feet uld demonstrate, even to the skeptical, the variations in cli-te between these two altitude levels. It can be readily under-od that climate is one of the many environmental factors cessary for the balancing of the organism. Seasonal conditions, change from a high to a low altitude, climatic disturbances h as electric storms and fluctuations in temperature strongly luence the physical and psychic welfare of children. A sudden nge from a temperate to a tropical or sub-tropical climate, rticularly at sea level, often has a debilitating effect and may use mental and physical sluggishness and loss of appetite. This

depression disappears if the child is removed to an altitude of from 3,000 to 6,000 feet, even in the same latitude.

Suitable regional adjustments result in improved metabolism and development. Huntington says that the maintenance of the level of human energy and achievement is the function of climate.

There is a suitable climate for every type of child and for every form of nutritional disease. Just how much the climatic environment stimulates the psychomotor mechanism is not known, but it is reasonable to suppose that solar radiation at different levels exerts a strong influence. A moist atmosphere weakens the effect of the rays. Irradiation, more powerful at lower levels, is directly or indirectly conducive to growth, for, other factors being equal, the greatest development in height occurs at the time of greatest radiation. Incidentally it has been noted that the hair and nails of children grow more rapidly at sea level and in the summer than in the mountains or in the winter.

The respiratory rate varies during the year. Linhard found distinct differences between the frequency and depth of respirations during the dark Greenland winter months and during the sunlight summer months at sea level.

Wherever there is strong radiation there is a building up of protoplasm, an active metabolism, and the blood has a higher hemoglobin content. Isachsen in Oslo and Von Vogel in Hamburg demonstrated that the hemoglobin content of the blood in anemic children on sunless, windy days remained unchanged.[33]

Loewy classified climate as sea level, desert, tropical, and high altitude. Each variety has its individual characteristics. Similar altitude levels, however, may show varied climatic conditions.

SEA LEVEL

Children living in northern regions at sea level where high winds blow inland from the sea tend to have an increased metabolism rate, with accompanying symptoms of hunger and thirst. In tropical countries, protein metabolism is probably less satisfactory at sea level than at higher altitudes. The apathy and listlessness of children, even in the early part of the day, are in strong contrast to the energy, vigor, and enthusiasm of children in the north at the same time and at the same level. In the north the growth impulse is stimulated and there is usually an increase in weight.

The climate of the New England coast differs greatly from that of the South Atlantic or Pacific. On the Gulf coast of California

gh temperatures and warm wind produce sweating and a wet in, while on the Alaskan sea coast low temperatures and cool nds cause the skin to be chilled and dry. Between these two tremes organic disturbances may vary in character. It is ticeable that further inland there is a tendency for both sys-lic and diastolic blood pressure to be higher than on the ast, where both are often low.

DESERT CLIMATE

The climate of the desert of Sahara corresponds to that of her wastelands and therefore may be taken as typical example. bservers have noted a fall in systolic blood pressure among the tives of that region. A high blood cell count was present both the natives and in newcomers suffering from arteriosclerosis d nephritis. The hemoglobin content of the blood tended to crease among those not inured to the climate, and there ap-eared a distinct swelling of the skin capillaries and an increase the erythrocytes of the blood, partly as a result of the high mperature and the desert winds. When thirst was present there as at the same time a marked distention of the capillaries of e skin. The slightest muscular exercise tended to increase the ulse rate to a greater degree than would occur in the temperate nes. The heat regulation of the body was found to be about e same in natives and in those unacclimated, but on the whole the natives it seemed to be better adjusted. Profuse sweating characteristic of desert climate because of the great dryness of e air and of the high temperature of the winds. Contrast this rofuse sweating with the perspiration in the temperate zones, the esult of moist air, low temperature, and cooler winds.[33]

TROPICAL CLIMATE

While heat and dryness are the outstanding features of desert limate, warmth and dampness are characteristic of tropical limates. In tropical regions profuse sweating produces a coat-ng of sweat over the surface of the body, thus impeding heat limination. However, the better a person becomes acclimated the tropics the nearer will his heat regulation conform to that f the natives, for heat regulation soon adapts itself to the limate. At best, the relationship between perspiration and the egulating mechanism of body heat is difficult to understand.

In the tropics basal metabolism first falls, then gradually re-urns to normal. Observers have discovered that different races

have different basal metabolism rates. Children from higher altitudes at first show increased muscular activity, which gradually declines; lassitude and listlessness taking its place. When moderate pigmentation takes place on a clear skin the ultra-violet rays of the sun probably penetrate to the internal organs. When irradiation of the surface of the skin is intense a deeper pigmentation results, which acts as a protector to the internal organs from the sun's rays and prevents the overheating of the body, as radiations do not readily pass through it. Dark skinned children, particularly those of the Latin races, suffer less in hot, sunny climates than do the fair skinned.

Red blood cells and the coloring matter of the blood tend to increase in hot climates, while the salts of calcium and cholesterin probably decrease in amount.

The sugar content of the blood is higher and glucosuria is common. As a rule, blood pressure is low and the pulse rate high in children unaccustomed to hot, humid climates. It is best, therefore, to curtail animal protein foods somewhat, so that body heat may not be unduly raised through the specific activity of these proteins. The appetite is less, the gastro-intestinal secretions are changed, and there is a loss of weight, for the water content of the body is depleted.[33]

HIGH ALTITUDES

The effects of high altitudes on metabolism have probably been studied at greater length than those at lower levels. In high altitudes the air is thin and dry, radiation is less intense, and there is a certain atmospheric invigoration. Often the purity of the air is so marked that pathogenic micro-organisms cannot live. The dryness, purity, and invigorating effects of the air, the low temperature, and balmy winds contribute to the alleviation and to the cure of certain somatic conditions, of gastro-intestinal disturbances, and of allergies such as hay fever, bronchial asthma, and other respiratory affections. Pigmentation is light and the light rays penetrate through it to a great depth. The higher the altitude, the less amount of perspiration, and thirst is not acute. Occasionally the sun's rays produce on a sensitive skin a moderate erythema which tends to absorb the ultra-violet rays. The red cells of the blood, rather than the blood plasma, are probably the agents of this absorption. This deep absorption of the rays by the erythema has a marked beneficial influence on the capillaries under the skin surface, for even after five or six

ths after the pigmentation or erythema have long disap-
red the capillaries still retain some of the original effects and
be aroused afresh by mechanical means. Irradiation by natu-
nethods is more efficacious than that produced by the quartz
t, for surrounding factors of air, altitude, and atmosphere
lude any intensive burning over limited areas. Natural
nentation undoubtedly protects the child from the intensive
a-red radiations.[33]

igh altitudes strongly affect the composition of the blood
metabolism in general. Viault, when climbing the Peru-
Andes, demonstrated that his blood cell count rose. The
was associated with a gain in blood nutrients; as he climbed
ner he found that his spleen in contracting threw certain sub-
ces elaborated therein into the blood stream. A storage of
l nutrients took place in the splanchnic nervous system and
the circulatory apparatus of the skin, whence more basic
stances were thrown into the circulation. Young blood cells
e formed and bone marrow became a deep red. The higher
went the more the red cells increased. The cholesterin con-
of the blood changed.

lood changes in high altitudes are many in kind and obvi-
ly influence the bio-chemical changes in different organs.
mineral salt content is particularly affected in such organs
he liver, lungs, heart, kidneys, and spleen. Viault noticed,
ever, that while calcium was increased, potassium was dimin-
d. With these blood changes went changes in the respiratory
pulse rates, in gas exchange, and in blood pressure. At low
tudes the respiratory inhalations show a greater depth than
se in high, bringing a larger amount of oxygen into the lungs.
ngs, heart, and the vasomotor system feel the lack of oxygen
nigh levels.

t unsuitably high altitudes susceptible children and those
ering from anemia may complain of a tremor of the fingers
ich soon passes with rest and change in oxygen supply. Un-
ditioned children may show moderate psychic reactions, such
uncontrolled emotionalism, laughter, joy, and outbursts of
husiasm, and physical and physiologic reactions of muscular
rgy, hunger, and appetite.

Both the cerebrospinal and the vegetative system are affected.
suitable high levels children show a gain in blood sugar,
od pressure, and blood calcium; the electrolytic channels and
hormones are affected and function of the endocrine system
ncreased, particularly the thyroid gland.[33]

Kestner of Hamburg and his associates have shown that at high levels healthy children showed increased oxygen consumption, increased nitrogen retention, red blood cell regeneration, and a rise in the hemoglobin content of the blood. It is obvious that anemic children can be benefited accordingly.[33]

Loewy says that in high altitudes certain elements of unknown origin are found, which provide nutritional substances for blood formation. Because of the activity of the thyroid, hemopoiesis occurs at high altitudes. Certain cases of rickets which prove stubborn even under proper nutrition tend to improve in suitable high altitudes, with balmy, cool winds, dry, thin air, and natural irradiation.[33]

The composition of the blood and the percentage of oxygen consumption is an important correlation in the maintenance of health in children. The blood takes up oxygen by means of the hemoglobin in the red blood cells and carries it to the organs and tissues. During rest the volume of blood in the lungs changes about once per minute, but during exercise it may change oftener than ten times a minute for adequate oxidation. Normally, arterial blood contains from 94-96 percent of its hemoglobin in oxygenater form, but at rest the blood is probably saturated with from 60-85 percent. During an ascent to higher levels this percentage of saturation in a sensitive child sinks, and when the percentage of oxygen consumption is reduced physical and sensory symptoms may make their appearance. When the arterial blood is imperfectly saturated the condition is known as anoxemia, which may be detected by a bluish coloration of varying degrees and which is associated with moderate cyanosis of the mucous membranes. There appear also peculiar nervous and mental changes which vary with the individual and the percentage of oxygen deficiency. Many of those changes are so undefined that they are not readily recognized until peculiarities of behavior occur. A change to lower altitudes causes a disappearance of these symptoms.[33]

Many susceptible children suffer from what is known as altitude sickness. Basilevich experimented with healthy young subjects placed in an experimental chamber, first under conditions of normal atmospheric pressure and later in rarified pressures corresponding to those at a height of from 3,000 to 5,000 meters. He was able to demonstrate that rarefying the atmosphere to make it correspond to that at a height of 5,000 meters resulted in the reduction of the percentage oxygen saturation of the blood from the normal 94 to 100 to from 68 to 98 percent. The injurious effects of lowered atmospheric pressure on the human

anism and the consequent development of altitude sickness the result of oxygen deficiency manifested by arterial anoxe-a. The compensatory regulating mechanism of the body, a cent to a lower altitude, and a greater oxygen consumption evented the occurrence of serious symptoms. At high altitudes lmonary ventilation and oxygen consumption increased from 100 percent above normal. The pulse rate, the systolic, and minute volume of the heart increased, as did the oxygen lization coefficient, the hemoglobin, and the erythrocyte ount.[34]

EFFECTS OF OXYGEN DEPRIVATION
PHYSIOLOGIC EFFECTS

The physio-chemical processes of the child's organism are ected by the amount of oxygen consumed. The child breathes order to obtain a supply of oxygen for the organs and tissues, throw off carbon dioxide, and to maintain a gaseous balance. veolar air is brought into contact with the lung capillaries m an exchange of gases between the air and the blood. Due to dilution by the residual air there is a reduction of oxygen in alveoli of the lungs averaging 14 percent. The average nount of carbon dioxide in the lungs is 5.25 percent. The nous blood coming to the lungs gives off carbon dioxide and kes up oxygen until it comes into equilibrium with the air of alveoli. Because the pressure of oxygen in the alveoli is eater than that in the blood, oxygen is absorbed into the ood. A very slight alteration in the carbon dioxide pressure the alveoli causes great changes in respiration. For instance, ring exercise more oxygen is absorbed by the tissues and a eater amount of carbon dioxide is given off. An increase in spiration immediately takes place, which washes out the cess carbon dioxide and restores the equilibrium. The respira-ry center benefits from oxygen consumption, but not to the me extent as does the body from carbon dioxide.[33]

The psychologic effects in the treatment of psychologic dis-rbances in susceptible children are often attributed to nutri-on, to irradiation, and to certain other environmental factors, it proper consideration has not been given to oxygen con-mption at suitable altitudes. Many infants and children often ffer imperceptibly from oxygen hunger and many have a toler-nce for particular amounts of oxygen varying with the indi-dual. It is possible that this tolerance is governed somewhat inheritance. The research work of McFarland proved that cer-

tain basic psychologic processes which occur in human behavior are due to oxygen deficiency. Insufficient oxygen consumption may reflect in some way on the body mechanism and provide a clue to the perplexing problems of physiologically and psychologically backward children. The air which the child inspires at sea level contains approximately 20.96 percent of oxygen; 79 percent of nitrogen; 0.04 percent of carbon dioxide and minute percentages of the rare gases, argon, neon, xenon, krypton, and helium. Hershey reported experiments in which animals were placed in an atmosphere of 21 percent of oxygen and 79 percent of nitrogen. When these gases were excluded the animals did not live longer than 10 days. He concluded after further experimentation that those unrecognized gases may play a similar role to that of oxygen in daily life. As the child ascends from sea level to a higher altitude he experiences the effects of a diminished atmospheric pressure, a lowered temperature, diminished humidity, and oxygen deficiency.

However, abnormal psychologic reactions are probably not due to mechanical or atmospheric pressure but to the diminished pressure of the atmospheric oxygen and a consequent decrease in the oxygenation of the arterial blood. At any high altitude a given volume of air contains less oxygen than at sea level, in which case the blood can hold less oxygen. It is possible to approximate these results at sea level if the subject breathes a gas mixture low in oxygen content.[13]

INDICATIONS FOR CLIMATIC THERAPY IN CHILDREN

Indications for climatic interchange are many and varied, but many obstacles stand in the way of its proper performance. To remove a child from an unsuitable climate, from a faulty environment, to conditions and locations more suited to his organic needs and development is often an economic impossibility. Usually severe organic dysfunctions preclude high altitudes, but many children suffering from mild nutritional disturbances often improve in such surroundings. Children suffering from certain forms of tuberculosis associated with cardiac disease and from scrofulous and infiltrated tubercular lymph gland infections do better at the seashore than in the mountains. Sea shore climate is also indicated when the Shick test demonstrates lack of immunity, particularly when the loss is associated with malnutrition. Children deficient in immunity, susceptible to frequent colds, to

nchitis pertussia, to adenoid growths, and to glandular en-
gements, and those with narrow chests, malnourished bodies,
l associated faulty growth prone to pneumonia and bronchi-
asis, improve better in the beginning at moderate altitudes,
rticularly in lake regions. After acclimatization they may be
noved with safety to higher altitudes. Older children suffer-
; from asthma are benefited in high and dry climates. Chorea
best treated in home surroundings. If a child dislikes the
vironment best suited to his needs, the less favorable climate
ay in the end prove more satisfactory. For those unfortunates
o have inherited major dysfunctions, usually one climate and
itude is as good as another.[35]

Many nervous children are often difficult to treat. Some are
ctims of inherited dysfunction, of sensitization to disease, and
disease potentialities; others suffer from the economic condi-
n of the parents, from malnutrition, and from restrictions in
ay and exercise. Each type of child may require a specific
vironment, which includes altitude levels, moisture or dryness
the atmosphere, cool or balmy winds, high or low tempera-
re, and moderate or more intense reactions from the ultra-
olet and infra-red rays of the sun. Sudden changes in weather
d seasonal changes may affect susceptible children more than
anges in altitude levels. Many body aches and pains of un-
rtain origin, such as joint aches, headaches, muscle pains, even
ilder forms of digestive disturbances, are the result of these
eather conditions.

In cold and harsh climates children may complain of a mild
sfunction when the air conditions reach a certain intensity.
ne might possibly speak of such children as "electro-meter"
dividuals. There is undoubtedly some connection between
any somatic disturbances and certain changes in the electro-
ynamic state of the air, manifested in the so-called connection
rrents which accompany the formation of rain, snow, hail,
g, etc. Susceptible children should be removed from this
nvironment to a more suitable one.[35]

Epidemics of certain diseases have been notably mild in some
egions and severe in others. Barometric fluctuations may be a
ictor in producing virulent strains of microorganisms from
armless varieties and in the sudden lowering of the child's
esistance to bacterial infection.[36]

Many children living in high altitudes in New England are
usceptible to colds, to bronchitis, and to sinus infection. At cer-
ain periods of the year, notably in the late autumn, winter, or

early spring, a visit to the local school often presents a spectacle of watery noses and eyes, puffiness of face, possibly a mild fever, and pain referred to the nasal sinuses. In older susceptible children severe sinus infection may develop later on. There are two general types of sinus infections; the catarrhal, and suppurative, and under the latter are found such varieties as the hypertrophic, polypoid, allergic, atrophic, etc. A bacterial check-up of smears taken from the noses of malnourished children has shown the presence of pneumococcus, staphylococcus, and less frequently the streptococcus.[36] In the treatment of these infections, local applications are not as efficacious as nutrition and environment, and a climate interchange is very important. When practical, susceptible children living in unsuitable climates should be sent to those regions lying well to the south. Texas has a very adaptable climate, a low relative humidity, no fog, an average maximum temperature of almost 80 degrees, an average minimum temperature of about 50 degrees, comparatively few days of rainfall or of high wind velocity, and clear days numbering 200 or more a year and practically 80 percent of sunshine.[36]

In the large cities of the northern hemispheres the effects of climate, poor diet, overcrowding, and inadequate ventilation tend to incite colds, bronchitis, pneumonia, and rheumatic conditions. Among the foreign born, the night air is considered dangerous and a cold breeder, and poor ventilation in the houses results in decreased vitality in delicate children, and in the prevalence of influenza, scarlet fever, measles, diphtheria, and gastro-intestinal disturbances.[36]

Many organic dysfunctions, many disease potentialities, and many nutritional disturbances find in climate interchange better biological conditions. Children who have lost weight often show a gain.[37]

Potentialities for certain diseases in the south of England, Germany, France, Russia, and the United States are different from those of the northern areas.[36]

Many metabolic diseases occur in one locality and not in another. Highly neurotic and excitable children suffering from an overstimulation of the endocrine gland system, from spasmodic appetite, and from insomnia and restlessness improve when removed from high to a low altitude. Many children living at low altitude levels where the climate is hot, moist, and enervating respond to higher location by increased energy, a higher metabolism rate, and increased mental and physical activity.[37]

Indeed, the role of the endocrine glands, and the thyroid in

rticular, in relation to climate is of great importance. In the st place they tend to maintain oxygen balance. The active inciples of the thyroid gland, the pituitary body, and the lrenal glands all speed up metabolism to a greater or less egree.[13]

In regions such as those of the Great Lakes where climatic tremes with wide fluctuations of temperature are common, ere often results a high incidence of metabolic diseases. In a ore even climate, as that of the Pacific Coast, such disturbances e less frequent. Much the same contrasts are seen in Europe, d many diseases are characteristic of certain localities. In andinavian countries metabolic diseases assume a different rm from those in many parts of Italy and Jugoslavia. Is it not ossible also that in an unsuitable climatic environment the nctions of the endocrine system and other organs suffer pathogic changes, and crime develops in adolescent youth?

Lombroso noticed that crime was more frequent in the southn parts of Italy and France than in the central and northern ortions. In England and in the United States juvenile crime is ore frequent in the hot humid summer months than in those f the winter.[13] To a lesser extent an overstimulation of the ndocrines may result in dissociation of brain, body, and environment, which gives the victim no rest or ease or the pleasure nd benefit of simple living.[37]

CLIMATE INTERCHANGE AND BEHAVIOR

Huntington states that character in the broad sense of indusry, honesty, intelligence, and strength of will is largely deendent on physiologic processes. Many children who at a low ltitude are physically and mentally backward improve when emoved to high altitudes. Precocious children, mentally and hysically over-stimulated in high, often become more normal t lower altitudes. Criminologists have noted changes in the ehavior of criminals after they have been transferred to alterate climates. It has been observed that natives of the South Sea Islands, New Guinea, Bush Australia, and those from the nterior of Africa have altered in characteristics, in intelligence, nd often in health when transplanted elsewhere. The story is old of a native Samoan and Tahitian who lived for many years n Alaska and who so changed in habits, characteristics, and cusoms that they were never afterward able to accustom themselves o their former conditions. The mental and emotional differences etween children living in extremes of climate are as noticeable

as are their physiologic and cultural characteristics. These divergences are less in evidence in intermediary climates. Nansen and Novakovsky have commented on the loss of interest in the Arctic for the surroundings and for beautiful landscapes. Moral, intellectual, and artistic pursuits found no attraction and there arose emotional outbursts known as "Arctic hysteria," the result probably of the long dark days and nights.

Changes in behaviorism which occur in children in Canada and in Northern New England during the cold winter months of the winter are different from those of the summer, and are probably induced by the excessively cold, long, sunless days, and improper nutrition. In the southern parts of this country there is found a lowered metabolism rate in children, which may show itself in listlessness and unassertiveness. In unsuitable climates emotionalism may lack control and children be prone to sudden anger, jealousy, and unreasonableness. Older children are given to passion in their loves and hates. Unacclimated and susceptible children suffering from oxygen deficiency at high altitudes may develop a peculiar irrationality, irritability, and many pseudo-psychologic tendencies, a spirit of revolt which makes them uncompanionable and anti-social. These symptoms are undoubtedly due to an accelerated metabolism rate wholly unsuited to that type of child. Scientific investigation corroborates clinical findings. In England, Vernon studied industrial fatigue in relation to atmospheric conditions and found that a rise in temperature and humidity decreased the amount of production and increased the number of accidents. It has been observed by clinicians that the child's sick days are more numerous in winter than in the spring and summer.[13]

HELIOTHERAPY

The solar spectrum shows a succession of colors like those of the rainbow; at one end red at the other violet. Between these two extremes there range the colors of orange, yellow, green, blue, and indigo. Beyond the visible violet there are the invisible rays of the ultra-violet and beyond the visible red the invisible infra-red.[38]

Sonne regards the solar spectrum as consisting of a simple series of calorific rays. He divides the infra-red rays into external and internal groups, the latter being continuous with the red end of the visible spectrum.[39]

Actinotherapy or radiotherapy includes not only ultra-violet

diation, which is beyond the visible violet in the solar specum, but also the luminous and infra-red or heat waves. The fra-red waves occupy a position beyond the visible red end of e spectrum and have a greater wave length than the visible d. The luminous and internal red rays are only slightly abrbed by the skin, while the external are markedly so. When e actinic rays pass through matter their intensity is reduced in nount, depending first on their wave lengths and second on e nature and thickness of the absorbing medium. This absorpon may be so great that radiation is practically reduced to zero a small thickness. For example, visible light radiation is cut f completely by opaque materials and media such as leather nd heavy fogs. Transparent material such as glass cuts down e intensity by only a small percent.[40]

Hill found after extensive study that most of the short waves f the sun's spectrum were lost in the heavy smoke blackened reas above the city of London. Larsen and Godfrey made obervations at Riverside, near the Pacific coast at sea level, and at an Francisco, Seattle, and Honolulu, on the deflection of adiation, and found wide variations, even on days apparently lear, due undoubtedly to the differences in the amount of moisure in the upper air strata. They concluded that the potency f the short wave energy reaching the earth's surface varied so idely that to properly estimate the dosage of sunlight for atients observations would have to be made daily.[41] Visitors ho have strayed around the docks of London and those of ittsburg, Pennsylvania have noted many signs of rickets and f other nutritional diseases in children living in these localities.

An American physician practicing in Mexico city was asked hy signs of rickets were seen so infrequently in the children here, even in the squalor of the slums. He replied that, although nalnutrition and filth were common, the atmosphere was clear, he days warm and sunny, and the children lived most of the ime in the open.

Children from northern climates and cities, suffering from ubercular lesions of various kinds, and who have been referred o Florida, California, New Mexico, and other warm climates where ultra-violet radiation is intense, have shown a reduction in fever, a disappearance of night sweats, an improvement of metabolism, an increase in weight, a diminished tendency to hemorrhage, and even the formation of scar tissue on the sites of the tubercular lesions.[41]

Solar radiation, in its passage through the atmosphere, may

be depleted mainly by two causes, absorption and scattering. Absorption is due to gases which compose the atmosphere and takes place in those portions of the spectrum which are characteristic for each gas. Water vapor and carbon-dioxide cause absorption chiefly of the infra-red; oxygen and ozone of the ultra-violet. In the antirachitic portion of ultra-violet radiation there is a slight absorption of ozone. This gas is nearly constant for all parts of the earth's surface, since ozone is held in the layer of the atmosphere 30 to 50 miles above it. Scattering of solar radiation may be divided into two types; that due to dust particles and that due to atoms, molecules, and ions of the gases, which are of greater importance in the ultra-violet than in the regions of longer wave lengths. It is particularly pertinent to study the observations of Hill, Frawley, and Pettit, whose results point definitely to the conclusion that in high altitudes of arid and semi-arid regions the percentage of short waves reaching the earth is much higher than in low altitudes where humidity is greater and where population is dense as seen in London, Paris, Buenos Aires, and other cities.[41]

ULTRA-VIOLET RADIATION

Therapeutically, the most important of the solar rays are the ultra-violet. They are present at the extreme limit of the sun's spectrum and have a wave length of 290 mu., being the shortest detected on the earth's surface in the middle of summer when the sun is at its zenith and the atmosphere is clear. However, these rays differ in wave lengths and many of the shorter waves never reach the earth's surface, for they are absorbed by the ozone in the upper reaches of the atmosphere and become less and less as they reach the earth obliquely. Indeed the absorption of the solar ultra-violet waves by the atmosphere is greater than that for the other actinic rays, and the obliquity of the angle at which the sun's rays strike the surface of the earth affects the intensity of their radiation at the earth more than that of the light or heat waves. In the winter at sea level, 305 mu. and in the summer about 295 mu. are probably their low limits. The most important range of the solar ultra violet-rays are those between 310 and 290 mu. From December to February, the shortest rays have wave lengths of 312 mu.; from March to May, 310 mu. It has been estimated that less than one percent of the sun's total energy is contained in short wave radiation. However children playing in the open probably enjoy a total output of sunlight energy of one gram calory per square centimeter per minute.

Ultra-violet radiation above 320 mu. passes through window ass; those below 320 mu. do not. Vita glass transmits about 60 rcent at 320 mu.; 30 percent at 290 mu.; and 20 percent at o mu.

The actual solar ultra-violet radiation necessary for the health children depends upon the scattered light from the sky or at reflected from sun, water, sand, etc. This scattered light ay be very high in ultra-violet radiation and varies less than rect sunlight throughout the day. Direct sunlight may be minished by light clouds and smoke. Scattered ultra-violet diation is markedly increased when snow covers the ground, is easily demonstrable in extreme northern climates.[42;43]

ULTRA-VIOLET LIGHT AND METABOLISM

Scientists have long known that the heat and light from the n directly or indirectly provides the basis of life. Primitive ople recognized this also, which may partly explain their worip of the sun. The influence of the solar rays on the maturing plants has long been noted, but that irradiation plays an portant part in metabolism and in the prevention and cure nutritional diseases is possibly not so well understood. The tra-violet rays not only aid metabolism by decreasing blood essure in hypertensive children, but through their action on e organism they affect the proteins, nuclei and intermediate rms of metabolism, mineral salt metabolism, and aid carbonoxide metabolism as well. These effects are probably produced a higher degree by the natural than by the artificial rays, for ey tend to diffuse over a wider surface. However, artificial light ay be employed with great benefit in places, in climates, and seasons where natural radiation is weak or absent.[33] Obsertions have shown that ultra-violet radiation is of marked lue, particularly in rickets, tetany, and associated conditions, rough raising the calcium and phosphorus percentages in the ild's organism. Calcium and phosphorus deficiency is present infantile rickets, tetany, osteomalacia, osteoparosis, and caries, id all are associated with an inadequate amount of vitamin D.[43]

Ultra-violet irradiation and vitamin D in moderate doses tend bring low blood calcium or phosphorus up to normal levels increasing intestinal absorption. Large doses of irradiated gosterol given in excess produce a hypercalcomia, through the moval of calcium from the bones, and bring about the pathogic calcification of many organs, especially the arteries and dneys. Vitamin D possibly produces these pathological changes

through the parathyroids as intermediaries. The amount of vitamin D required to ensure a normal level of blood calcium differs with child, the diet, the utilization of the calcium, and therefore with metabolism.

The manner, however, in which vitamin D controls calcium and phosphorus metabolism is not clearly understood. It may increase the absorption of these salts by increasing the acidity of the gastro-intestinal tract. The failure of efficient bone calcification may be due to an insufficient intake of calcium or phosphorus in the food, a too low quantity of vitamin D, a lack of ultra-violet radiation, a lowered absorption power, an increased secretion of calcium and phosphorus in the intestines, to a low total calcium, or to one of low ionization, to a low phosphorus in the blood plasma, to a failure of the bone enzyme, or to a disturbance of the parathyroid glands.[42]

There is a close relationship between irradiation and the activation of vitamin potency, which can be demonstrated in the slow recovery from a deficiency disease even when a plentiful supply of vitamin foods is added to the diet but without irradiation. Even when one or more necessary vitamins are included, recovery may be either slow or fast, varying with the organic need for a particular vitamin, the rate of metabolism, or the degree of radiation. Sometimes where the recovery from a deficiency disease because of a lack of vitamin B is fairly rapid, vitamins A and D may be slow in producing results.[44]

The importance of ultra-violet radiation is well illustrated in a deficiency disease with a disordered mineral metabolism, as shown in defective calcification of the bony tissues during the child's developmental stage, apparently because of a defect in the mechanism of calcium phosphate deposition by the bony cells formed from the cartilage.[45]

In young active children with a high metabolic rate where calcium deposition is rapid, a dose of cod liver oil or irradiated ergosterol added to a diet rich in calcium may increase its absorption and retention, whereas in less active children with a lower rate there may be mobilization with increased excretion.

As the relative efficiency of cod liver oil, ergosterol, and ultra-violet radiation varies in different children, possibly resulting from the inheritance of potentialities or from faulty environmental factors, treatments often have to be empirical in character.[42]

The effects of irradiation on the growth of young rats is seen in an experiment which parallels those on children. In young

ts on a diet deficient only in the fat-soluble vitamins A and D, owth was increased when the animals were irradiated daily a mercury vapor quartz lamp, and there was a temporary sumption of growth in those rats which had ceased gaining in eight. It was found that the lamp could not entirely replace the t-soluble organic growth-promoting factors in the diet, for, spite continued daily exposures to the light, these little animals ased gaining in weight at a point below the normal for their e, and their subsequent history proved to be the same as that rats on the same deficient diet without irradiation.[46]

While adults on adequate diets with irradiation show noconncing evidence of an increased growth rate, children on a tamin D deficient diet have accelerated growth and recovery om a deficiency disease such as rickets after proper irradiation om the sun or from the quartz lamp. It is strange, however, at when groups of children are exposed to ultra-violet radiaon they usually have an initial increase in their growth rate hich is temporary, for at the end of a number of months the radiated group are no heavier than the controls who received light treatment.[47]

The recognition of ergosterol as pro-vitamin D and its presice in skin fat suggests that this vitamin may develop in the in and be absorbed. As the penetrative power of the ultraolet waves is believed to be slight, any direct action would be nited to a very thin layer of skin. If, however, it can be asmed that the antirachitic rays do penetrate the epidermis and ach the capillaries, they may produce a direct action on the ood. Clark has shown that the ultra-violet rays cause an crease in the diffusible calcium in the serum of the blood and is action may be involved in the calcifying action of sunlight. ess and Lundagen showed that there was a seasonal tide in the vel of the blood phosphorus in infants, reaching a minimum in inter and spring and a maximum in summer.[45]

SUNLIGHT AND BONE DEVELOPMENT

Clinical experimentation on children is usually limited to pecific cases, but when more detailed knowledge is desired aniials are preferred. The results of the following experiment on vine may show an analogy to those on children suffering from ckets, where bone formation and bone rejuvenation are indiated. There is a pathological condition in swine known as iffness, paralysis, or rickets, which is due to improper nutrition.

The principal and constantly occuring lesions are in the bones, and are the result of a deficiency of calcium and phosphorus. The condition occurs when the ration is low in calcium or in that factor which aids in its assimilation. An addition of these salts to the diet cures it. Findings showed that this "stiffness" was apparently the result of a faulty mineral metabolism, as the swine were herded in sunless pens without access to solar radiation. Further observation showed that sunlight affects mineral metabolism in growing pigs much as it does in children. It was noted that 8 pigs fed on a low calcium ration, or else low in that factor aiding its assimilation, developed the characteristic symptoms of rickets within 4 months, when deprived of irradiation. On the other hand, other pigs which received the same ration but with access to direct sunlight showed that solar radiation exerted a marked effect in increasing the ash content of bones and almost normal formation of bone took place. Spectacular results were achieved, however, when the experimental animals were fed a high calcium ration and then exposed to irradiation. Steenbook and his co-workers demonstrated that a ration high in calcium and phosphorus yet low in the antirachitic factor produced excellent bone development when the animals were exposed to light.[48]

LIGHT TREATMENT AND RESISTANCE TO DISEASE

Efforts to produce immunity by balancing metabolism and by destroying microorganisms are greatly aided by irradiation. The actinic rays, particularly the ultra-violet, affect the potency of the vitamins and of other nutrients, thereby stimulating an increase in vigor and energy which favor immunity as well as growth and development. Depending on the condition of the child, often on its race, its degree of sensitization to infection, and on proper irradiation, the resistance to microorganisms may be either increased or lowered. An example is seen in chickens, which are more sensitive to the light rays than are rodents, which do not require them to mature. Chickens show a marked resistance to intranasal inoculations of the pasteurella avicida, the etiological factor of fowl cholera, after daily exposures for a month to ultra-violet radiation from a quartz mercury lamp. It has been observed that when a disease develops slowly, or is at its initial stage, irradiation tends to increase resistance to it. However, when metabolism is badly unbalanced and when bacterial infection is intense no notable improvement may take place.[42]

IRRADIATION AND MICROORGANISMS

Beginning at approximately 313 mu. the sensitivity of micro-
ganisms to irradiation increases with a decreasing wave length,
aching a maximum of between 265 and 280 mu. and then a
nimum at about 240 mu. Experiments on the coagulation of
otein solutions by ultra-violet radiation show a close relation-
ip between the sensivity curves of bacteria and of proteins
these rays; it may be safely assumed, therefore, that bacteria
e destroyed as a result of the changes produced in all cell
oteins at wave lengths shorter than 313 mu.[42]

Wave lengths of the ultra-violet between 290 mu. and 250 mu.
mulate haemolysis, and the growth of certain strains of bac-
ria is affected.[33] While rays measuring from 310 to 290 mu. are
owerful preventatives of disease, they are likewise bactericidal
d aid in curing rickets and anemia.[43 33]

The shorter the ultra-violet rays the more rapid is their bac-
ricidal action, because of their selective affinity. Radiation at
5 mu. is intensely destructive to certain bacteria such as the
lon bacillus and the staphylococcus.[43]

THE INFRA-RED AND LUMINOUS RAYS

In sunlight the infra-red rays, after they have passed through
e atmosphere, extend from 760 mu. to about 5 mu. Sunlight
ses these rays above 5 mu. upon reaching the earth. Longer
fra-red rays, those from 5 mu. to 15 mu. predominate in arti-
cial light sources such as in carbon arcs, radiant heaters, and
candescent lights. The mercury arc light possesses some of the
nger infra-red rays, for they arise from heated electrodes, quartz
urner, and reflector. Infra-red rays above 1.4 mu. are heated
y water vapor and water. Rays up to 1.4 mu. penetrate the skin
about 25 millimeters. The long heat waves from the lamp
re absorbed by the skin and stimulate nerve endings during
heir rapid absorption and may set up an intense physiologic re-
ction and erythema.[42]

Visible red and invisible infra-red radiation have been used
treatments for years, but it is only within the last decade that
hey have been scientifically applied. Improved methods have
xtended the limit of the infra-red range to longer and longer
ave lengths. Infra-red rays cannot be differentiated from the
est of the electro-magnetic field as the only wave length which

produces heat. Therapeutic heat radiations may be grouped under two heads; luminous and non-luminous. Luckiesh has divided the infra-red into three regions; the near, the middle, and the extreme. Among the luminous rays are found the natural heat of the sun, of which 80 percent consists of the infra-red rays. The physiologic action of the luminous and infra-red rays, whether photochemical or thermal, must be preceded by absorption by the skin and tissues. This law applied equally to the ultra-violet, visible, and infra-red rays. A part of the benefit which children derive from heliotherapy is probably due to a combination of the infra-red, the luminous, and the ultra-violet rays. When extensive solar ultra-violet irradiation is indicated, infra-red light had best be present only in small proportion; it is therefore necessary to choose a locality where the infra-red rays are proportionately few.[39]

However, there is apparently a certain relationship between the waves of the infra-red and those of the ultra-violet in their effects on the organism, for in combination their effects are in many respects greater than when the ultra-violet is administered alone.[40]

PENETRABILITY OF THE ACTINIC RAYS

The particular response of the skin to irradiation differs in intensity and therapeutic value with different skins, races, and individuals. Obviously the actinic rays do not react on the skins of negroes as on those of the light skinned races. Children with blond or reddish hair and with pale, light colored skins are often seriously affected by a too prolonged exposure to ultra-violet light either from natural or from artificial sources.[33]

The ultra-violet rays probably possess but slight power to penetrate normal skin tissue, but if it is rendered bloodless these rays can penetrate to some extent. They are health builders, for though invisible and incapable of penetrating deeply, they act chemically because of their rapid absorption, for blood and serum absorb the rays freely.[43] The physiologic action of the luminous and infra-red rays, like those of the ultra-violet, is preceded likewise by their absorption by the skin and tissues.[40] In overdosage however, they set up marked physiologic reactions and pathologic changes in the organism.[43]

Sonne, Campbell, and Hill have shown that the luminous rays penetrate the skin deeply and provide heat for the subcutaneous tissues. They reach the capillary blood vessels, so that the temperature of subcutaneous organ is 3.4° C. higher than that of

e skin. The orange and yellow portions of the spectrum are obably the best sources of the luminous rays, because of their gh intensity.[39]

Certain long waves at the visible red end of the spectrum have strong penetrative power. For example, if the hand is held o to a powerful lamp such as the incandescent filament bulb, d light is seen passing through the sides of the fingers. This dicates that a slight thickness of tissue transmits a certain poron of the red light.[40]

Rays of shorter wave length reach only the superficial strata the muscles under the deep fascia. The visible green and yelw rays have an intermediate penetrative power and the invisible eat waves are feeble in comparison. It is doubtful whether the ys of shortest wave lengths penetrate deeper than to the subidermal capillaries, while those of longer length do not peneate even that far.[39]

Ultra-violet light radiation, contrary to that of heat and light, enetrates the shadows. Bernhards has demonstrated that chilren living on the shady side of a narrow valley or in homes ithout sunlight suffer less from rickets than do those living irectly under it.[33] Formerly it was believed that the solar rays hen acting on the skin affected the nervous system and the red lood corpuscles reflexly. At present these rays are considered esponsible for a chemical process or processes involving subutaneous tissues, for the natural long waves of the ultra-violet ave apparently rather deep penetrability and therefore so inuence radiation that blood calcium and blood phosphorus are narkedly affected and there is seen an improved callus formation fter fractures.[33] Scientists point to the fact that when the skin s damaged by over-irradiation a lethal chemical substance is ormed which may be distributed to various organs and tissues nd cause serious disturbances.

The skin changes physiologically and chemically from irraditon and there occurs pigmentation and a proliferation of basal ells. Blood pressure, pulse rate, and respiration also respond o irradiation of the skin, and these internal effects may remain long time in the organs, tissues, and blood after irradiation has eased.[33]

Benoit claims that with proper dosage the infra-red rays increase the number of red blood corpuscles in the blood from 15 o 25 percent, this increase persisting for 5-6 weeks. Through heir action they tend to diminish the number of white blood orpuscles and are therefore beneficial in leucemia, particularly of the splenic type.[22] What Sonne calls the internal red rays

penetrate the subcutaneous tissues to a greater or lesser depth and affect the blood, lymph glands, nerves, and nerve endings.[39]

ARTIFICIAL IRRADIATION

Because of absorption and scattering, because of smoke, dust, clouds, and other handicaps, many of the short invisible ultra-violet rays either do not reach the earth during certain seasons of the year or else they are badly thinned before they do. In those localities where and when these obstacles occur, artificial irradiation by means of the lamp is a good substitute for the natural. The quartz mercury lamp is restricted to the emanations of the chemically active violet and ultra-violet rays and produces an artificial light which in its spectral composition closely resembles sunlight and in this form probably possesses a greater degree of concentration than many other kinds of lamp. While the actinic rays of the sun are diffused over the whole body those from the lamp strike a smaller area of skin surface and are more direct. Ordinary lamps of the carbon arc type and the mercury vapor lamp give off infra-red radiation to a greater or less degree.[49]

Many contend that natural sunlight rather than the artificial is the best actinic agency for producing chemical reactions on metabolism, for it diffuses over a wider area and its rays, not being as centered, cause an energizing and invigoration of the whole organism. Quartz light does not possess the coordinating qualities of natural light. Even the penetrability of the quartz lamp is sometimes questioned. Macht and his associates, however, studied the penetrative power of the ultra-violet rays on the tissues of living animals, such as rabbits, cats, and dogs, with the quartz spectroscope and spectrograph. The skin was irradiated with a Krohmayer and Hanovaria Alpine sun-mercury-vapor lamp and a spectrophotograph of the waves which passed through the skin was obtained while the animal was alive and its blood circulating. In some of the animals the longer ultra-violet rays were shown to penetrate not only through the skin but even through the whole thickness of the abdominal wall. Wave lengths of 300 Angstroem units were frequently obtained with both lamps, although the abdominal wall was three or four millimeters in thickness. These investigators found also that in dead tissue there was greater permeability than in living normal skin. When the skin was preserved either by freezing or by preservatives such as formalin or alcohol the coagulation of the proteins and the other chemical changes produced rendered it more

aque. Thus leather was found more opaque than living skin. here is a marked difference, as has been said, in absorption of e rays between the skin of a negro and that of a white man. the former there is absorption in the entire ultra-violet irradi-ed region: conclusive evidence subsequently showed that the netration of the ultra-violet rays from powerful modern quartz mps through animal tissues was much deeper than heretofore spected.[47]

Among the many bodies contained in the blood stream are e erythrocytes, the leucocytes, lymphocytes, the hemotoniae and e plastocytes or blood-platelets. Sooy and Laurens have dem-strated that sunlight produces an increase in the blood plate-s and in the red blood corpuscles of young rats. They showed so that solar radiation produced an increase of the blood plate-s in humans, notably when treating 10 cases of idiopathic pur-ura hemorrhagica by the use of the mercury quartz vapor lamp. hat the short invisible rays from the mercury vapor lamp pene-ate into the blood stream may be further illustrated by an periment on rabbits.

Six rabbits, all under eight months of age, were exposed daily the mercury vapor lamp. The treatments were given at first r five minutes at a distance of sixteen inches, but the time was creased daily from two to three minutes until a maximum of irty minutes was reached. The longest period of treatments as twelve days. It was found that the normal average platelet unt on these young animals increased from 700,000 to 1,040,000, me animals varying more than others. The peak occurred etween the third and sixth day and reached a point between 490,000 and 1,890,000. The red cells in every case showed a ogressive decrease during the first few days of irradiation; a rcumstance which might in small part have been due to slight emorrhages. In four of the six animals the red cells began to crease either just before or just after the platelets had reached eir highest peak; the other two were not studied beyond this oint. In the first four animals the original normal red cell unt recovered in from four to six days after it had dropped to s lowest level. In three of the animals, and within a period f less than two weeks, the red cell count rose to over a million igher than the original.[47]

INDICATION FOR IRRADIATION THERAPY

The ultra-violet, the infra-red, and the luminous rays singly nd jointly perform their allotted tasks in the prevention and

cure of disease, in the relief of pain, and in their sedative action on the organism. Before beginning any treatment with irradiation, due consideration should be given to the form to be used, to the type of disease, to the sensitiveness of the skin, to the time of year, and to the selection of the solar or artificial rays, etc.; for it is obvious that treatment from the scattering, thinned solar actinic rays cause less reactionary conditions than do the more direct and concentrated rays from artificial sources. Being diffused, sunlight acts on the body as a whole and there is less danger from over-dosage.[39] When treating infants and children with the lamp it is well to proceed cautiously and slowly. Many sensitive skins often suffer from even moderate dosage of ultra-violet radiation, even when indirectly exposed, and there may result an extensive inflammation of the skin with resulting reflex disturbances of fever, irritability, restlessness, and prostration. In metabolic disturbances such as rickets, tetany, and allied conditions, natural ultra-violet solar radiation produces changes in the blood count and in the bactericidal potency of the blood, for it acts as a biologic agent in the regeneration of red blood corpuscles through its mobilization of the iron supply. It not only acts together with nutrition as a preventative and cure of these diseases but as a general physiologic tonic to organic function.[47]

When treating rickets and other metabolic disturbances by the solar rays in autumn, winter, or early spring, particularly in the temperate zone, it should be remembered that the sun's antirachitic beams are at their highest potency at midday. Consequently, outdoor exercise at this period of the day is more beneficial and healthful in convalescence from this disease than is that practiced within doors and from ultra-violet radiation through quartz glass.[45] In certain forms of secondary nutritional anemias ultra-violet radiation stimulates the formation of reticulocytes.[47]

Organic conditions such as deficiency diseases, sensitivity to frequent colds, disorders of endocrin function, nutritional disorders, muscular pains, rheumatic conditions, loss of weight, acidosis, some types of allergia, etc. are markedly benefited by ultra-violet radiation from sunlight or the lamp. However, there are many skin lesions in which, owing to these factors, application of the ultra-violet rays seems to bring about more improvement by the use of quartz lamp than from the solar waves. These are eczema, seborrhoea, urticaria, pruritus ani and genitalis, necrotic papules, anterior and posterior cervical gland infections, impetigo contageosa, furunculosis, acne vulgaria, and many other skin disturbances.[49]

rradiation from sunlight or from artificial sources should not allowed to produce its effects immediately, but rather over a riod of time.[44] When stimulating the potency of the anti-hitic factor in the breast milk of nursing mothers, irradiation m the lamp can be made more intense and periods of treat-nt nearer together.[43]

Fortunately any disturbances from overdosage rarely prove ngerous, but lethal dosage has been known however to cause eat harm, for it affects the cells of the body. For these mothers d for children exposed to refracting radiation at the seashore, ., Fuchs suggests a protecting salve composed of lanolin with 4 percent solution of naphthol-sulpho acid.[49] Children with s sensitive skins obtain a mild erythema and resulting pigmen-tion. A moderate erythema has a physiological effect and pig-entation acts as preventative to overdosage.[43]

The luminous rays of the sun are valuable in many nutritional sturbances as well as for the relief of pain. It is therefore visable during the spring, early summer, or fall to place the ing child under the luminous rays of the sun, but to cover its e with a thin white cloth. The exposure of the body surface rough penetrable clothing first causes a vasomotor dilatation, increased flow of blood and lymph, but if the exposure is too olonged a temporary hyperaemia or erythema is produced. here a gentle breeze is present a longer exposure may be ap-ied, for then the physiologic effects are greater. Under the minous rays, properly applied, the child often falls asleep, for ey penetrate deeply and induce drowsiness. Children are found have varying degrees of sensitization to exposure to the minous and heat waves. Indeed, some are affected by the rk heat waves from the house radiator.[39]

TECHNIQUE OF APPLICATION

The technique of application with the infra-red lamp differs om that of the ultra-violet. In the latter, the best results are otained from an exposure over as large an area as possible. Vith the former, application over a small area affords the best sults.

The dosage of the rays, particularly ultra-violet, is largely ependent upon the physical environment and the physiologic ondition of the patient and less on the time of exposure. With e quartz lamp, however, the environmental factors are negli-ble and the distance from the lamp and the time of exposure e most important.

The time of exposure to ultra-violet and infra-red beams should be governed entirely by the reaction of the child, and irradiation should cease immediately when the skin shows a faint reddish blush. It is rarely necessary to treat infants with the infra-red lamp. Older children should be given the treatment with caution, for the overheating of the internal organs may result in internal disturbances. The factors of age, sensitiveness of the skin, and the emotional reactions caused by the attendant, the surroundings, and the glamor of the lamp should be taken into consideration.

The burner should be at a distance of 35 inches or less, the time of exposure from two to ten minutes, and treatments should not exceed two a week. The face and neck should be covered with a towel.[43]

HYGIENE AND SANITATION

THE ANCIENTS

Scientists tell us that among the earliest forms of life there was no such thing as disease, and therefore no need for sanitation. We have no information as to when the idea arose that clean living decreased the hazard of disease, or why it was that primitive religions laid such stress on cleanliness. Probably hygienic observances, like art, developed from religious ritual. Many diseases were looked upon as the "exercise of some power in the Universe greater than man" and methods of divine healing were derived from natural sources. Herodotus refers to many form of prophylaxis and treatment, such as blood letting, vapor baths, massage, the use of heat and cold, poulticing, counter-irritants, etc.[50 51]

Hippocrates early pointed out the principles of sanitation, and since his time no one has improved fundamentally upon them. Summed up, they were air, aliment, exercise, rest, sleep, wakefulness, repletion, and evacuation. He advised also the control of the passions and of the affections of the mind, and an exact balance between food and exercise. He believed that certain diseases were caused by excesses in either direction. The Greeks and Jews were well in advance of their times in their sanitary rules and regulations.[51]

The inventiveness of the early Greeks, Romans, and other peoples in social hygiene was truly remarkable, for they had absolutely no foundation to build on. Probably the drainage system of the Royal Palace at Kuossos, in Crete, was the earliest

mple of its kind. A main sewer of masonry work and four ge stone shafts descended from the upper stories and opened a stone conduit communicating with it. Even at that early iod drainage from the roof was connected with the sewerage, l in addition to carrying off rain water these shafts acted as tilators and probably containers for household refuse. On h floor there were especially constructed chambers which newhat resembled "dumbwaiters" and communicated with shafts. The remains of a primitive water-closet have been covered, showing traces of a wooden seat and of some sort of ter flushing system. Even though they are considered primi- e by modern sanitary experts, they were far in advance of ny out-houses or privies still seen in the hinterland of Canada d the United States. Bath rooms also were in use and even limentation tanks, which were probably connected with the ter supply. Pipes of terra cotta with beautifully cemented nts were laid on concrete beds. Modern plumbing has done no tter.[51]

The personal cleanliness of the early Egyptians is proverbial, d the washing of their clothing was considered a domestic ty. Earth closets were in use and drainage by pipes practiced. ring excavation of the ruins, a complete house drainage sys- n was discovered. Fumigation for infectious diseases probably iginated at about this time.

From Crete and Egypt knowledge and culture passes on to eece. The Grecians, always progressive, introduced new hy- enic methods of public health. No people before or since has proved on their bodily fitness.

Their aqueducts, unlike those of the Romans, were generally bterranean. Storage cisterns connected with street fountains ere in use, a system which might be likened to the present drink- g fountains for horses and dogs. The houses of the wealthy ere equipped with latrines of simple construction, situated on e street, and they drained into a sewer beneath which was ap- arently flushed by slop water.

During the Hellenistic era, scant notice was paid to sanitary rangements in private dwellings, attention being focused on ublic buildings. Later on, in the Macedonian period, less terest was shown in public buildings and more paid to homes nd to better housing. Child recreation centers or open play paces were apparently few.

From the earliest days in Greece, physicians formed a distinct ass and commanded great respect and consideration. Socializa- on of medicine by the state was unthinkable, and physicians had

a free hand in applying recognized and scientific methods in sanitation and hygiene.

They were not hampered by politics, quacks, or pseudo religions and cults. Their observations regarding the effects of climate, seasons, and environmental factors on health and disease were exacting, detailed, and scientific.

Victorious Rome was herself subdued by the arts of peace and the Romans in the earliest days of the Empire may have found that bad sanitation was an enemy of community health and indirectly a foe of proper nutrition, for they raised the standard of hygiene by their structural sanitation works. Compare the baths, the fountains, the sanitary measures, the cleanliness and order of the streets of those days with the conditions existing in the chief municipalities of the world, with the exception of Berlin. The cities and communities were better flushed and drained than was Rome herself by the famous Cloaca Maxima, which dated probably from the Tarquins in the Sixth Century, B.C. There were numerous sewer connections which carried off both storm water and sewage, for into these underground sewers drained the public latrines and those of any private houses situated near them. In Rome, even in houses located on out-lying streets and away from the main thoroughfares, excreta was received in cess pits, which, under strict regulation, were cleaned out at regular intervals and their contents carted beyond the city limits. Refuse was never allowed to accumulate in these pits beyond a certain level or to pollute the surrounding air.

Household refuse was collected at night and taken to dumps outside the city environs and burned. A mighty arcade was situated at Segovia, and long lines of arches stretching across the Roman Campagna insured sanitary provisions over a wide area.

Some of these Roman aqueducts were from forty to fifty miles in length and in the palmy days of Trojan and Nerva Rome received 332 gallons or more of water per person daily, an amount considerably in excess of that supplied to London and Paris today. This supply compares well with our own magnificent Croton water system. Concrete channels brought the water to Rome and to a large cemented reservoir, whence lead pipes carried it to private homes and to public fountains. Many Roman cities possessed filtration plants with porous stone for the removal of impurities in drinking water. So progressive were the Romans that even in the provinces the system of water supply was nearly as elaborate as in Rome itself. For example, in Carthage during Hadrian's time, an aqueduct 80 miles in length

constructed which delivered six million gallons of water
y into the city, and decantation cisterns with strainers at-
ned were employed for the removal of filth. Lead pipes guided
water to homes and fountains.

'he flower of the Roman sanitary measures blossomed in the
ctural designs of their public baths. In Greece, bathing was
sidered secondary to athletic exercises. Among the Romans,
vever, the baths came first, and these gradually developed into
borate centres of social activities. Dare we make a compari-
? These social events might well correspond to the cocktail
ties held today on the brink of private swimming pools on
ntry estates. Roman baths were gorgeous affairs. The earliest
bably were built about 21 B.C., and from that time on they
reased in number, size, and elaborateness, until, at the time
Constantine, there must have been nearly 800 in Rome alone.
The baths of Diocletian, inaugurated 305 A.D., measured a
e in circumference and accommodated some 3200 bathers.
e larger baths were ornate in character. Often there were
ee main divisions; the bath room, containing the hot bath,
sudatorium, the hottest room, and the cold room with the
mming bath, practically a modern Turkish bath. The hot
ms were heated by a system of hot air flues running in the
lls and beneath the floors. These contained the hot water
es and thus preserved their heat.

Nudism was an institution, and young men and women re-
ned nude, or partially so, in the sun, for sun bathing for
lth was a custom widely recognized. From Seneca one learns
t rooms in bathing houses had large windows providing light.
deed, the remains of such a solarium have lately been discov-
d in Hadrian's villa at Tivoli. The use of soap was undoubt-
ly familiar to the Sumerians as far back as 2500 B.C., and
ping oneself appears to have been a common practice among
e Romans.

The heating of the houses of the poor was effected by the
ypocaust," a system of hot air carriage from a large wood fur-
ce in the basement, the air circulating through flues in the
lls and beneath the floor. Yet some of their dwellings, prob-
ly in the poorest quarters where the inhabitants lived in huts
d wooden sheds, had no heat at all except in the bath rooms,
any of the Romans relying on charcoal braziers.[51]

The Romans were excellent colonists and they brought to
itain many of their sanitary and heating innovations. They
id out streets and also paved them. Sunlight was dear to these
lonists and some of the wealthier ones glazed their windows

with translucent but non-transparent Roman glass. Roman drainage was installed in the cities, but for some reason unexplained they built no water systems. However, excellent roads were constructed, probably for the transportation of troops.[51]

THE DARK MIDDLE AGES

Sanitary measures during the dismal period of the Dark Ages suffered a distinct relapse, and the nutrition of the people suffered also. Infections of one sort or another made uninterrupted progress. After the period of Antonines, Graeco-Roman culture sank unbelievably low as compared with that of earlier times. All science died down to the merest glimmer in Europe.

The Arabs in a measure saved the day, for they established great educational centres at Bagdad, Cairo, and Cordova, where, beside mathematics and astronomy, medicine was taught, and in a primitive way preventive medicine and the control of epidemics.

During this scientific blight which spread over Europe, the Moslems began establishing hospitals, the Mansuri Hospital at Cairo being the most celebrated. This is probably the first hospital in history. Primitive it was to be sure, but there were, at least, different wards for different diseases, and a stream of water ran through each ward. Infant nutrition was haphazard, poor in quality and in quantity, and infant mortality reached a high level.

Eventually the glory and learning of the Arabs passed away, and all their manuscripts perished. During this period there were few measures and no evidence of even an approach to the skilled early Greek and Roman scientific methods of sanitation and personal hygiene. Conditions became so chaotic that some monasteries established infirmaries, notably one at St. Gall, in the ninth century, where were found separate wards, bath rooms, warm rooms, a doctor's house, and physic garden.

After the death of Charlemagne even these improvements began to decline, and again the decay of science came about. During the twelfth and thirteenth centuries, there grew as flowers on an unfertile soil religious orders, which for the most part deteriorated, only one remaining true to its high principles, the Benedictine monastic system, which more and more exercised a broadening effect on medieval culture and possibly on medical science.

A touch of modernism is shown in the sanitary methods of the famous community at Monte Cassino. It was in the year 525 A.D.

Benedict, the monk, emerged from his twenty-five-year re-
nent in the cave at Subiaco to found their famous institu-
, that "School of God's Service," whose communal ideals and
enic manner of living he had designed to replace the austeri-
and individualism of Anthony and the ascetics. He wore a
perly-fitted dress, duly adapted to the seasons, and changed
t regular intervals, proving his understanding of personal
ene. A straw mattress, as well as a blanket, coverlet, and
ow, lay upon his bed, and unconsciously he may have sensed
ernism in that he shared his couch with no one. He stepped
into antiquity, however, when he admonished that the
of baths be granted to the sick as often as it shall be ex-
ent, but to those who are well, and especially to the young,
s shall seldom be permitted." It may be that the excessive
ing popular among the Romans was in Benedict's mind when
framed this precept. By the eighth century regular baths
e unknown in the monasteries. Bathing two or three times a
and the washing of the feet once a week was all that was
e. Cleanliness of the hands and of surroundings, as well as
nliness in the preparation and serving of food, was strictly
oined, as was the washing of clothes at regular intervals.

n approach to modernism was seen in the position of the
tory, which was close to the refectory and furnished with
boards for towels. There existed also a regulation that hands
e to be washed before and after meals and table cloths and
kins were to be laundered when necessary. The monks were
uaded not to dump fish, meat, or other edibles from their
chers on the table, not to crack nuts with their teeth for
er guests, nor to cough or sneeze on the food before them,
were they to wipe their hands nor clean their teeth on the
e cloths, a common practice at that time.

ot much can be said of hygiene in England until the later
dle ages. The Anglo-Saxons lived in one long room, in which
, women, children, and animals herded, slept, cooked, and
in communal discomfort.

ater more rooms were added and greater privacy prevailed.
ong the wealthy, conditions were improved. In the homes
oth rich and poor open fires were in use, so that the tenants
e on one side of their bodies and were scorched on the other.
s misfortune drove them to seek warmth and comfort at the
l inn or smithy, a custom still existing in some rural parts
Great Britain. Faulty heating combined with poorly con-
cted windows rendered the houses bitterly cold, and for some
xplained reason furs and warm clothing were put on indoors

but taken off when going outside. At this period good lighting and ventilation did not exist.

Outside the houses and running through the middle of the street was an open drain, and pigs, cattle, ducks, men, and women dumped their collective filth and excreta, along with the carcasses of slaughtered animals, into the sluggish stream. The richer class had cesspools in court or garden, which were cleaned out only at long intervals. We may well believe that a common latrine between Moorgate and Finsbury in England, indescribably foul, was the instigator of that frightful epidemic in the reign of Henry the Sixth.

The Roman practice of supplying a city with pure water is in strong contrast to the custom, during the reign of Henry the Third, of using water taken from the river or from shallow wells which were terribly polluted. Even with subsequent moderately improved measures water purification was not established. The garbage and filth of New York's bathing resorts of a short time ago may remind one of the wholesale pollution of the rivers and the impassible condition of the streets in the reign of Edward the First of England. Later in this king's reign, conditions did become better, and throwing rubbish into the town river or into the streets was forbidden. The authorities arranged for the collection of all refuse at stated intervals and had it transported to pits outside the city.

Even in this dark period laws were in force which required every citizen to clean the pavement in front of his house each Saint's Day under penalty of a fine. This was to prevent pestilence. One wonders often if those health authorities worked as hard as do our own, and with so little encouragement and aid. In spite of all the efforts of far-seeing and public spirited men, no real solution of sanitary problems was accomplished during the Middle Ages, for the ignorance and fatalism of the masses were so deplorable that no legal measures were successful. A similar condition is apparently found today in the mountainous regions of Haiti.

The observance of personal hygiene during this period rose or fell, depending on social or economic changes. It was low at times, but among the upper classes a jug and basin were provided in the sleeping room, and hands, face, and teeth were washed each morning. Elaborate bath rooms sometimes existed. A picture now before us, a lampoon, shows a much worried individual in a bath tub with a crown upon his head, and his hands and face depicting anxiety. On one side are three men in armour, one holding a pole or spear against the bather's chest,

other stands with sword uplifted, and the man in the rear, ling his weapon in front of him, appears to be ready to tor- t the bather. Spitting, even at table, was a common practice. here was an appalling mortality rate from childbirth and ase, and of those who survived many were deformed and pled. The spirit of constant unrest, as seen in the wandering rds which travelled from place to place, caused an over- rding of inns and homes and fostered disease and infant tality. The herding of families together induced inbreeding affected the national physique, a lowered vitality induced ase, and the mass constantly conveyed it. It is therefore easy isualize the cause of famine, plague, leprosy, St. Anthony's (ergotism), scurvy, syphilis, malaria, and various skin af- ions which caused social havoc at that time.[51]

THE SIXTEENTH CENTURY

merging from the gloom of the Middle Ages, people discov- the sunshine in a gradual resurgence from semi-barbarism, re men perceived once more real life and the beauty of the ld in which they lived. Intellectual inquiry then arose, stimu- d afresh by each new innovation and discovery; in fact, a re for nature study. "Why," writes a physician of the time, nature given us our eyes and other senses unless that we ht rely upon ourselves in the quest for what is true?" There e an unquenchable thirst for novelty and adventure, a ed of old restraints, and a desire to follow knowledge beyond utmost bounds of existing human thought.

rinting was introduced, and science began to visualize life, ointed out in the work of Linacre, physician to Henry the nth, of Andreas Vesalius, and others. In spite of intellectual ancement, represented by cathedrals, colleges, and schools, mass of the people lived and died in an atmosphere of dense erstition which threatened the accomplishment of great sani- measures. Fairies and goblins, ghosts and devils, charms divinations held full sway; there was a widespread trust in ological predictions and a great interest was shown in emy, etc.; features which certainly persisted to this day.

uring Elizabeth's time an advance was made in personal iene. Public baths existed and "the Queen doth bathe her- once a month whether she require it or not." Soap was only the wealthy and the use of pungent perfumes smothered y unsavory body odors. The hygiene of eating improved, as as table manners; handkerchiefs came into use; glass vessels

provided cleanliness; and pewter spoons and platters provided means for obtaining and holding food instead of dipping hands into trenchers and pots, much as do the Bedouins of today.

Child nurture in Elizabethan times is of special interest. Infants were confined from birth in swaddling bands and kept largely indoors, receiving very little fresh air and exercise. On account of a wide spread superstition that cleanliness deprived them of their "nourishing juices" they were kept always filthy. Breast feeding, in contrast to our times, was practically universal, and "wherefore it is agreeable to nature so is it also necessary and comly for the oune mother to nourse the one child," Thomas Faier tells us in his *Books of Chyldren,* published in 1567.

In the few cases of artificial feeding recorded, bread or pulse were generally used, while cows' milk is apparently not mentioned. That physical qualities could be transmitted by milk even Faier believed, for he quotes an ancient authority that "lambs fed on goats' milk grow wool lyke the heare of Goates," and the fear of mothers that their infants might acquire bovine characteristics may have prevented them sometimes from using it. An inadequate diet, faulty hygiene, and long hours of drudgery made the lives of children unhappy. Little Lady Jane Grey conned her Greek lexicon in her thirteenth year and also began the study of Latin at an early age.[51]

Toward the close of the sixteenth century, with increased national prosperity, housing and domestic hygiene, at least of the better classes, began to improve. Brick and stone displaced timber in the construction of homes, windows increased in size and number, and large glass-filled oriels became a feature. As Greene well remarks, "the prodigal enjoyment of light and sunshine was a maker of the temper of the age." Greater domestic comfort was enjoyed by nearly all classes. Carpets, matting, or sanded floors replaced the rushes of former days, household furniture was narrower but more was used, and even the poor had comfortable beds with pillows, an improvement over straw pallets or rough mats, and they had a good bolster or pillow under their heads instead of a round log, Japanese fashion.

In London at this time, even while prosperity increased, sanitation of the streets and rivers was not observed and the deplorable methods of burying the dead became unbearable. In 1584, Bishop Latimer openly denounced St. Paul's churchyard for its constant and notorious smells and cited it as a cause of "much sickness and disease." There is no doubt that the "sweating sickness," typhus fever, scurvy, and shipboard diseases of the

ne were spread by unsanitary surroundings, and even syphilis ecame epidemic. At Oxford, where the glow of the Renaissance one highly, miserable sanitation became so destructive to ealth that a little band of reformers, forerunners of our health ıthorities, gathered around Dean Colet. They strove for na- onal education, a high standard of hygiene, and a responsive titude toward health and disease. They dreamed of a pure ater supply, broad streets, and ample gardens, clean markets ıd abattoirs, of the safeguarding of mothers in labor and of fant welfare, as well as the providing of nursery schools and unicipal nurses. Hospitals were planned and duly inspected ıd provision made for the isolation of contagious diseases and r the care of certain forms of sickness, both medical and sur- cal. In general, physicians were held in high esteem but were ıbjected by the ignorant and superstitious to an onslaught of tuperation and antagonism, scoundrelly attacks which have ersisted down the centuries.[51]

THE SEVENTEENTH CENTURY

The light of the Renaissance, which during the sixteenth cen- ry was only a glow, became during the seventeenth century flame, for observation and experiment were replacing custom ıd habit. Scientific physiology, the discoveries of Malpighi on e human circulation and of Van Leeuwenhoek in the birth of ıcteriology showed a changing world. Then again superstition ıd irrationalism raised their ugly heads and frightful persecu- on took place during the reign of James the First of England, ho decried these wholesale tortures which endeavored to stamp ıt these conditions. The church was also one of the greatest ıtagonists to enlightenment, and Galileo was persecuted in ngland. While Harvey experimented, wrote, and lived in peace ıd security, Sydenham appeared and remarked, "that true prac- ce consists in the observations of nature; these are finer than eculations." Wise words these, and later embodied in the ioughts of really great physicians.

Into the social flower garden there came a weed—child-labor, ith all the brutality and inhumanity of greed for money. As at e present time, the rich grew richer and the poor, poorer. here was a lack of food and work and accommodation for the oor, and sanitation became for the most part just a dream. This eriod of difficulty and inefficiency lasted until the passing of e Poor Laws of 1834. Overcrowding, homeless vagrants and eggars, and dilapidated houses all became a commonplace sight,

as they are at the present. Filth and dirt of the streets were scattered upon the passer-by, stagnant water and cess-pools became a horror, and the problems of the disposal of household garbage remained unsolved. City scavengers were supposed to carry away this refuse to dumps beyond the city boundaries or along the river bank, but they worked with the same unconcern as do many men now performing the same allotted tasks. In spots there were various improvements in sanitary administration, such as draining, paving, and street cleaning, but on the whole poor sanitation was the enemy of social health and the forerunner of vicious inheritance, just as the slum of today breeds hoodlums, human beasts, and prostitutes.

At about this time the people began to suffer from the familiar coal scourge, combined with the black, evil-smelling fumes from manufacturing plants. At the end of the century happier days appeared, plagues and famine, epidemics and syphilis gradually began to disappear, but small pox assumed severe proportions. Measles and scarlet fever raged and summer diarrhoea carried off a very large number of infants. Yet, "what price modernism;" for tuberculosis over all the world now kills apparently just about as many persons as the plague did then.

Fear and heroism played their parts in those early days as they do today, for with the first breath of suspicion that plague was in the house, the inmates, often already infected, fled, leaving the very sick to the health officers brave enough to enter. One reads, too, of the Vicar Thomas Mompesson in the little village of Eyam, England, who, though his own wife and most of all the 350 inhabitants had fled, with the exception of 29 others and himself, labored and sacrificed to withstay the London plague of 1665. At this time quarantine was strictly observed (1603) and clothes and bedding became recognized as sure sources of infection and were burned. Dogs and cats by the hundreds were exterminated to rid them of disease-bearing vermin. Probably about 1729 the wharf rat, both black and brown varieties, the house and sewer rat as well, were mistrusted as the carriers of disease.[51]

THE EIGHTEENTH CENTURY

The eighteenth century witnessed a great extension of those scientific advances which began during the Stuart regime. With Hunter and Morgagni, the tide of popular interest in social measures increased. Though ignorance, brutality, immorality, and crime ruled, yet seldom has there been a period in history before

r since when intellect was so widely esteemed, and as Voltaire rites in 1726, "Reason is free here and walks her own way." 'he yearning for knowledge engrossed all classes, qualities such s the flower of chivalry and respect for women ripened, and the ighteenth century far excelled the twentieth in these respects. opular works began to appear, such as the Encyclopaedia Briannica, circulating libraries multiplied, and books and periodials were more widely distributed. With such phenomenal imrovements, obviously sanitation improved also. Intelligent men aught that health and education, sanitation, hospitals, schools, braries, parks, and even art galleries should be the serious oncern of the state and the vanguard of healthy, rational hought.

Cyclonic evolution was evidenced by a passionate humaneness oward Society, to an increasing devotion to human welfare, and o social reform as seen in public health work and in the treatnent of the sick, of criminals, and of the insane and destitute; deals which are immature even today. John Howard, a magificent human and intellectual character of those times, clearly utlined his ideals, as did Jane Addams at a much later day. etter urban sanitation, a clarity of social vision, and wide-spread opular and scientific observances tended to diminish infection nd infant mortality, while vaccination saved many lives. Nutriion was better established, and in general the comfort and welleing of the masses were of a high order and conditions harionized more with our present-day efforts than ever they had one before.

At the beginning of the eighteenth century, the wet nurse 'as still in fairly popular demand. Artificial foods began to apear, pap-boats were used, and spoons of silver among the wello-do, whence arose the expression, "to be born with a silver poon in the mouth." Glass feeding bottles sprang into use, some tted with sponges, some with leather or decalcified bone teats. 'et even with the improved feeding bottle of today, satisfactory esults would have been impossible, as the milk was extraordiarily filthy and vilely handled. During this early period, the ondition of London's milk was notorious. Our own earliest ecollections are of filthy cows, milkers, unclean hands, and the ooling process carried on in a horse trough. In Europe milk 'as purveyed from a dog-drawn milk cart with large cans danling at the side, from which, at stated intervals, a prescribed mount of milk was poured into a more or less uninviting vessel. n many parts of the world, in earlier days, milk venders were onsidered declassé and were despised as too poor or too mentally

deficient to perform worth-while work. The milk suffered from a visit to the pump, brook, or spring before it reached the consumer. Cows were kept under the worst conditions, lacking sunshine, clean stalls, or proper fodder and fresh water. Many suffered from ulcers, tumors, and abscesses, while tuberculosis was rampant among them.

As time went on, infants were fed on arrowroot, isinglass, gum arabic, etc.; following which came condensed and dried milk. The year 1858 showed a nearer and nearer approach to present-day conditions, and hygiene and sanitation legislation was instituted. Evolution toward the betterment of sanitary measures has been dishearteningly slow, but rays of sunshine now and then peep out of overshadowing clouds to encourage progress.[51]

In the second half of the eighteenth century, roads, streets, and home improved. There may even have been a prevision of a balancing of metabolism, judging from the attention paid to agriculture and foodstuffs. Now appeared skylights, underground windows, and windows in passages. Still sanitation suffered in urban communities and intelligent minorities were unable to convince the population en masse that cleanliness was a social, personal, and economic life saver. The alleys and streets were badly cleaned, household filth was flung from doors and windows, and the dark places were offal dumps. The slaughtering of cattle was carried on publicly and church yards became so grossly overcrowded that the stench reached the tenants in the neighborhood. Yet, little by little as time went on, improvements progressed and gutters took the place of central canals, flat paving took the place of round pebbles, restrictions were placed on the blocking of roadways with refuse, and ventilation and lighting improved. Water supplies were less restricted and more adequate to the needs of the people. The water mains were made of elmwood, and not long ago one such main was dug up in lower New York, a relic of the Colonial water supply.[51]

The clothing of the people during the latter part of the eighteenth century was similar to that of the present day, and as time advanced the masses become more mindful of personal as well as of communal hygiene. Clothing fabrics were chosen for their suitability and laundering properties. Their dress became simpler; cotton and calico fabrics replacing those of wool. Linen became common, being used as at present for garments and bed clothing.[51]

One of the most vicious threats against health and sanitation in the eighteenth century, and one which worked havoc in infant and child nutrition, directly or indirectly, and caused a high

fant mortality rate, was the depraved spirit drinking of the asses, a situation not unlike our own prohibition adventure. picture of Gin Lane by Hogarth fosters temperance. For al-ost twenty-five years following 1725, every encouragement was ven to the production of brandy for the nobility, rum for the iddle classes, and gin for the poor, with the approval of Parlia-ent and that of the people. It was among the poor that the nsumption of alcohol was the greatest. Imagination running ot is unable to picture the brutalization of the people, their healthy condition, the appalling infant and child mortality, d the high suicidal and homicidal rates.

The vice grew to such a hideous extent that whole families ere regular drinkers, while infants were nursed on mothers' ilk poisoned with alcohol or else received it from the spoon or ttle. Drunken unfortunates polluted the streets. Water sys-ms, rivers, and dwelling places were foul with filth and infants d children lay amid excreta, while the floors and walls of vellings were plastered with it. A horrible picture this, and nditions became finally so bad that steps were taken to improve em, much as today municipalities enjoy sporadic reforms to ean house.

However, during the eighteenth century, infirmaries and dis-ensaries were established which were the forerunners of those ow flourishing all over the world. English institutions of those ys were foremost, and, apparently due to the flow of immigra-on to the new world, similar institutions and remedial measures ere installed on this side of the water. The infirmaries and spensaries of Europe were, in fact, the predecessors of the mod-n hospital. These establishments were primitive in character, owever; the beds were of wood and fitted with overhanging nopies attached to the four upright bed posts. The floors were nded, the walls filthy, while the building itself was often but crowded dwelling house. The wards were small and generally ercrowded, the windows were constantly tightly closed, and e toilets (privies), ill placed and almost wholly neglected. ermin was plentiful everywhere, but in some of the institutions, annual sum was set aside for its extermination. Howard, an nglish investigator, summed up their evil points as follows:—

1. The injurious prejudices against washing floors and admitting fresh air.
2. The rarity of bathing the patients, it being too much trouble for the attendants.
3. The vileness of the air in the wards, especially at night.

4. Great quantities of beer are served to the patients in the wards.
5. There are no convalescent wards for the patients discharged from the hospitals.
6. The profession of nursing is a liability rather than an asset.

The religious nursing orders had by this time practically disappeared, and the women now employed as nurses were drawn from the lowest strata of society, untrained, badly fed and housed, and poorly paid for long hours of arduous labor. Later in the second half of this century and under Lind's able teaching, many of these evils were eliminated. In particular, iron beds without canopies were provided. His reorganization plan was so proficient that it may well compare with modern ideas. Unfortunately, however, sickness and epidemics went on apace, and these improvements on the whole exerted little or no beneficial effects on the general health of the people and mortality still was high. At a later date there appeared some sort of social organization and the sick poor were attended in their homes, a system corresponding to the present day visiting nurse.

The art and science of pediatrics was born and maternal care was given serious consideration. Great advances were made in the rearing of children, for the whole conception of the child's position in society was changing and more value was attached to saving life. The public conscience became slowly aroused to the great infant and child mortality rate, which, quite apart from disease, grew higher and higher. It was common knowledge that numberless infants were murdered at birth, exposed on the streets to all kinds of weather, or put out to nurse amid the vilest surroundings. Even within modern times unwanted infants born of unmarried mothers in Austria were soon after birth farmed out to peasants for the rest of their natural lives under favorable or unfavorable conditions.

With enlightenment in nutrition, changes in infant clothing took place and the old custom of enshrouding the child became obsolete. The public became conscious of the benefits of sanitation, fresh air, and restful sleep in the health of young children. Around the year 1767, the artificial feeding of infants was placed on a more scientific basis and began to supersede the wet nursing which at that time was in its hey-day. This new style of infant nutrition attracted many young women looking for light work and better wages, but it was attended by such drawbacks as have seldom existed since. It was a crude beginning, but it persisted. The foods used for artificial feeding were crude and unwholesome

—"water-pap" or bread and water boiled together often supple-
nented the breast milk and there was a prejudice against cows' nilk. Sugar was added later and then a wide range of foods came nto use for the time being; beef tea, chicken broth, and alcohol n the form of beer and red wines. Underwood, who practiced t the end of the century and who wrote a book on the diseases of children, was one of the original parents of pediatrics, for it vas he who first advocated the use of animal milk as infant food. He particularly stressed cows' milk as most closely resembling hat of the human. A clear-thinking, practical, scientific man he vas, for he advised the boiling of milk and the addition of barley vater, and suggested bottle feeding only when breast feeding was mpossible.[51]

However, a pamphlet written by Dr. Cadogan in 1747 shows dvances in infant welfare, for beside stressing the importance of maternal feeding and inveighing against the fashionable wet nurse, he advocated the feeding of ripe fruit and vegetables to young children and emphasized the importance of fresh air and cleanliness.[51]

THE NINETEENTH CENTURY

The nineteenth century should be approached by easy stages, for it is not possible to make any decisive break between the eighteenth and nineteenth. The history of hygienic progress in general, and the progressive measures of sanitation in particular, during the last half of the eighteenth century and the first three quarters of the nineteenth, were, in truth, one continuous whole. The tide of philanthropy toward the underdog and the hygienic reform which arose near the end of the previous century flowed into the nineteenth. As at present, reformers became health- and disease-minded. Great men came into being and the work of Pasteur demonstrated that cleanliness of air, food, water, and of communities, as well as personal and domestic improved hygiene, were the fundamentals of practical sanitary reform.

Following the French war of 1815, there were twenty years of national depression and a temporary lull in hygienic progress. There was also a shortage of money, a wide-spread social unrest, a rapid increase in urban population, a falling off in sanitary achievement and in the hygienic welfare of the masses. This retrogression was fortunately of short duration, for the public was lashed afresh by alarms of cholera outbreaks and there was an overwhelming need for disease prevention. These problems were solved in a more scientific manner. In their devotion to

blue books, reports, and departmental efficiency instead of to scientific advances, Chadwick and Florence Nightingale were both typical of the antagonists to hygienic progress as expressed in the new-fangled germs and inoculations. The early part of the nineteenth century saw the gradual disappearance of epidemics as they formerly threatened, through improved sanitation, but cholera and diphtheria made their appearance. According to medical history, diphtheria has been known since the time of Galen and outbreaks may have occurred in the Middle Ages. Wartime conditions checked housing improvements which were started in the eighteenth century, and a period of national distress followed the peace concession. Depression and misery always react strongly on civic pride. In many countries and industrial communities there was no proper sanitation in the houses, no ventilation or lighting. Homes were poorly constructed, streets were badly paved. In some European countries, as in England and parts of this country, swine and cattle roamed the streets, and refuse was flung from doors and windows. Newspapers littered the streets and parks. The year of 1800 saw healthy hygienic and sanitary progress; garments were kept clean, bathing was popularized. A sewerage system of drainage by water was introduced and the extensive use of metal, of iron pipes, and mains became general, and outclassed the primitive but similar conditions of centuries before. Before the proper "wiping" of metal joints was understood, there was much leakage of the liquid contents of the pipes.

Interesting letters appeared in English and American literature which described the housing problems of those early days, and public baths and wash houses. These institutions appeared in England long before they did in this country, and probably originated there. The city of Liverpool inaugurated a public bath in 1842 and the completion of the project for supplying Glasgow, Scotland, from Loch Katrine in 1855 was undoubtedly the inciter of the magnificent water system of New York City.

At about this time cesspools and vaults were built underneath the dwellings. These were supposed to be cleaned out at regular intervals, but in the meantime the liquid contents continually percolating into the soil gradually saturated the ground on which cities stood, so that pollution of springs and wells followed at an alarming rate. Excreta was discharged into old sewers, and cities and towns in England and some in this country became more and more traps for excreta, with the result that ponds, rivers, water systems, etc., became lakes of sewage which yielded overwhelmingly nauseating smells. There is no doubt that many

idemics of history may be traced to the poisoning of drinking
ter. It was not until the latter part of the nineteenth century,
at more effective and scientific methods of plumbing and sani-
ion were employed, and the development of bacteriology began
solve the causation of epidemics.

While the advancing machine age was severely criticized, as
supplanted hand labor, it activated new means of transporta-
n and new industrial methods. It brought better living condi-
ns, especially to the masses, and improved sanitary devices.

Clinics and dispensaries were sorely needed and overcrowding
d lack of ventilation made living quarters unsanitary and un-
althy. No matter what the temperature, windows were for the
ost part kept tightly closed because the superstition prevailed
at outside air would cause colds.

Then came the day of sweat shops and piece work done in the
me, and many hundreds of unfortunates not only lived but
orked under intolerable conditions. Working hours from 3.00
.M. to 10.00 P.M. were not unknown. In one mill in England,
lled "Hell Bay," regular working time was from 5.00 A.M. to
oo P.M. and twice a week operators worked all night.

These victims of a non-union, slave-driving age became a prey
lead poisoning, potter's asthma, grinder's rot, glass worker's
nphysema, and the "phossy-jaw" of match makers. Incidentally,
ne should not forget the deaths among young women resulting
om the use of liquid radium on illuminated watch dials, which
ccurred recently in this country. At present, child labor in the
otton mills in the South is only a shade better than that same
vil suffered in England in the early part of the nineteenth cen-
ury.

Physicians, more than any other class probably, recognize the
ffects of over-fatigue, exhaustion, and unsanitary surroundings
n the germ plasm of parents, and the consequent transmission
f dysfunction and ill health to their children. To read of the
ruelties practiced at that time on little children in England and
n parts of this country is to remember the brutalities practiced
n war victims today by the Bedouin women of Arabia. Again
here came a reaction, and Percival, Fevuir, and others tried to
waken public conscience against such evils, and they were suc-
essful.[51]

THE MODERN SCIENCE OF HYGIENE AND SANITATION

Basically, the science of hygiene and sanitation has not changed
naterially, but it has proceeded by slow evolutionary stages to

its present position. Psychologically, sanitation and hygiene have undergone a marked transformation. The public has been aroused, has become philanthropic, saner, and more sympathetic to the public good, and more receptive of those hygienic and sanitary essentials necessary to a healthy life. Modern sanitary measures as a community responsibility may, to a large extent, be credited to the Jews. Moses was educated in Egyptian ways and his ideas of public health were undoubtedly founded on theirs and improved upon by himself. On research, one finds a series of sanitary rules elevated into a definite legal code and enforced on a whole nation. Notably, an order was given that accumulation of refuse must be disposed of by burying it in the soil.

Segregation in infectious diseases was insisted upon, and it is not hard to believe that adequate systems of plumbing and drainage were provided to assist the removal of contaminating materials. Well in advance of his time, Moses enjoined disinfection and various sanitary methods such as washing, the use of animal charcoal, the scraping of walls, etc., to remove infection.[51]

SEWAGE DISPOSAL

Present day sanitation methods dispose of sewage immediately and in a sanitary manner. It is not allowed to stagnate and to become the breeding grounds for micro-organisms which cause disease and, in rare instances, epidemics, or, by the lowering of vitality to disorganize metabolism. Particular attention is given to domestic sewage, to liquid or semi-liquid refuse from residences, from schools, and institutions for children, which contain the wastes from toilets and the slop water from baths and kitchens. Industrial wastes are still, in many instances, discharged into sewers, rivers, and brooks from industrial plants. Creameries, dye and metal industries in communities affect, through their odors, the proper balancing of nutrition. Incidentally, the olfactory effect of smells and odors on the health of the masses was recognized in the past as well as it is in the present. Asiatics modify their evil influences on the human organism by the use of overdoses of perfumes and sweet oils. They believe that perfumes tend to quiet the nerves and also leave an olfactory psychic impression on digestion and metabolism. Orientals often inhale and enjoy their favorite scent when resting after meals, in the belief that the mental state thus created induces relaxation and indirectly stimulates nutrition.[52]

Residence sewage is about 99.9 percent water, the other parts

ng paper and solids from the feces; also urine, wash water, l minerals present in the water. Sewage disposal is mainly di-ed into primary and secondary forms. The first involves the noval of a portion of the suspended matter from the sewage by eening or sedimentation, or both. The secondary treatment ovides for the septic or Imhoff tank with air, generally under nditions somewhat approximating those found in the soil. ter beds allow the sewage to percolate and come in contact h nitrifying or other aerobic bacteria coating the stones, which dize the organic matter.

The ideal disposal of sewage from residence, therefore, includes dation or its aerobic reduction in some form. This means that sewage is first run through a tank in which sedimentation a part of the solids as well as septic action take place. The tic effluent, however, is still putrescible and may contain dis-e bacteria. It must not be allowed, as was formerly done, to into an open ditch or even into a small stream, without treat-nt. It is often wise to make use of the filtering properties of soil by running a tank effluent through an open-jointed tile e placed not more than 18 inches beneath the ground surface. is allows the sewage to percolate into the soil, where it is ex-sed to the oxidizing action of soil bacteria.[52]

Carriage by water is the best method for the disposal of excreta own to date. Unfortunately, such a sewage system is found only large and rich communities. Owing to the expense of installa-n and maintenance, the poorer and sparsely settled districts e often unable to provide this method. In many small com-unities a private sewerage system is installed. Too often the eans of sewage disposal is a mere afterthought, a problem solved the digging of a cesspool or the building of a septic tank by local workman with more interest in his wages than in the ceties of construction. It is not strange, therefore, that the sspools and tanks often give trouble. Occasionally such an ar-ngement for sewage disposal may be found near some fine resi-nce and its penetrating odors may rival the most elementary thouse.[52]

Some years ago large or small municipalities situated on large kes and rivers discharged their sewage without treatment into ese bodies of water. They may have felt that their citizens were fe, inasmuch as the oxygen which is held in solution by the ater of these streams and lakes is taken up by the organic atter in the sewage until complete oxidation has taken place d purity established. Unfortunately they failed to realize that the diluting water had insufficient oxygen or if the water were

so scanty in volume that there may not have been enough oxygen available in it to prevent aerobic decomposition, there would have resulted those foul odors so characteristic of bacterial action. In addition, the water of the stream or lake may become black and unpleasant to the eye, cannot sustain animal life, and an Isaac Walton may whip a fishless body of water.[52]

As colon bacilli live in the intestines of men and animals, they obviously are found in the feces in large numbers. In small communities where rank cesspools still persist, and in water or soil which has been polluted with excreta, a number of these bacilli may be discovered. They often abound in the dirt of city streets and in houses as well, their presence amid unsanitary surroundings indicating pollution. Typhoid and dysentery microorganisms may also live in unsanitary soil. Typhoid bacilli have been known to live in solid feces from ten to twelve days. Dysentery bacilli live up to eight days, and the paratyphoid for a longer time. In pit-privy material which had been kept dry, typhoid and dysentery bacteria were found to have lived from ten to thirty days, while in moist soil these bacilli survived for 70 days. The reason that comparatively few deaths occur from the pollution of sewage and soil by these scourges is that soil bacteria are antagonistic to them because of their alkaline reaction.[52]

PENETRATION OF DISEASE BACTERIA THROUGH THE SOIL

It is, then, of vital importance to the health of infants and children that excreta and sewage be kept from penetrating the soil. We recall an instance where a typhoid carrier used an improvised bench over marshy land for excreta discharges. An epidemic of typhoid fever on the other side of a neighboring mountain soon afterward established the fact that surface soil pollution extended to the sub-soil and then to waterways, which on a limestone base penetrated the mountain range.[52]

Klighler has ingeniously proven that typhoid and dysentery bacilli do not spread to an extent in a horizontal direction, but in porous soils they are washed downward for a depth of two feet and in denser soils only one foot. Heavy rains or the constant dripping of water on surface soil may carry pollution to a depth of ten feet. The retention period of excreta in a septic tank being usually about twenty-four hours, it is apparent that septic tank effluent is potentially dangerous and should be con-

mned—many diseases such as malaria, yellow fever, the ague, and tuberculosis were formerly supposed to use this spitable soil for a breeding ground.[52]

Instances have occurred where wells were affected. It often ppens in vacation camps that excreta is deposited on dry, sandy il, but no contamination of the soil follows. If, on the other nd, excreta is discharged on moist soil some of it may be carried r long distances. The danger that ground pollution may affect mote villages and hamlets is very evident. Many rural districts ve, in consequence, unconsciously contributed to disease in at they have sanctioned the open back privy, which allows the creta to be deposited directly on the soil where the liquid part it soaks into the earth but the solids dry out. The soil may mediately become polluted with water-borne bacteria beneath e deposits and soon reaches its capacity for the reduction of e organic matter, and a highly disagreeable odor becomes no- eable.

Another contraption, one without water carriage, is the t privy, which consists of a hole dug in the ground, into hich the excreta is deposited and dried out. Another form is e vault toilet, which provides a water tight tank in which the ntents are partially liquefied. One may occasionally see the ptic closet, the box and can variety, and the chemical toilet, disposing of excreta without the use of water but all poten- lly dangerous.

The fact should not be overlooked that vegetables grown in ound recently fertilized with human excreta have propagated sease, and it is well known that many foreigners living in China pend on California products for this reason rather than upon ose grown in native soil.[52]

REFUSE DUMPING

For a long time New York and other North Atlantic cities prac- ed the dumping of refuse supposedly well out to sea. To carry is material from five to twenty miles from shore, requires an aborate equipment of loading wharves, tugs, and barges to ansport it. The refuse, including banana, orange and lemon els and the rinds of melons, often had an unfortunate habit of turning homeward, driven by shoreward winds, and polluting e bathing beaches. This rotting rubbish collected flies, rats, osquitoes, and other vermin. At the same time, nauseating ors penetrated to sections farther inland.

Of late however, Greater New York City has taken a decidedly forward step in the installation of incinerators. One in particular has a capacity of 750 tons of garbage daily. The dumping of refuse on land is worse even than that of dumping it at sea. Such a procedure may however result in an increased value to the land, particularly if such material is carefully chosen and properly covered. Many swamp lands have been recovered through the filling in with ashes and street sweepings. The fashionable Back Bay section of Boston, Massachusetts, is a notable example.

However, if filthy and mouldy garbage be deposited, the rat population of the refuse dump may increase amazingly, and disease be spread by these animals. Epidemics have even been traced to flies which had gorged themselves on the material in such polluted dumps. In certain communities where health authorities were lax, it was formerly no uncommon sight to see garbage cans and other debris, even dead cats and dogs, lying in the highways or in vacant lots. In many towns which do not insist upon strict and daily sanitary measures, there is often celebrated a yearly official farce in municipal house cleaning which is known as a "clean up" campaign, a makeshift; for no one can compute the amount of damage done to growing children who play around this refuse during the remaining parts of the year.

There are many incidental topics on sanitation and on sanitary protective methods for the guarding of infants and children against disease which the investigating parent may well consider. The characteristics, for example, of the mosquito, the fly, and the rat; their habits, life cycles, manner of carrying diseases, their various species, their habitat, together with methods for the restriction of the mosquito through drainage and the filling in of their breeding areas. Then too, there is the application of oil to kill the larvae; the use of creosote, lime, and Paris green, and the description and characteristics of the top-water or star-head minnow, which voraciously feeds on the mosquito larvae and pupae.

The characteristics, habitat, habits, and germ-carrying propensities of the house fly in carrying disease germs and the knowledge of how to restrict and prevent its activities are important considerations. Talks to children on fly bites and fly droppings should be a feature of every curriculum in both public and private schools. Furthermore, rodent control, the relationship of rats to public health, and the different ways of destroying them should be discussed.[52]

PLUMBING

Modern house plumbing has taken a progressive step in the ivention of gadgets of one kind or another. New buildings are ipplied with the latest innovations, and old buildings with their ck of even simple appliances are being torn down. A modern ome drainage system concerns every citizen, for it affects the ealth and nutrition of his family. House sewage may be potenally dangerous, in that it frequently contains disease producing acteria from the gastro-intestinal tract. Leakage and stoppage in is system may prove a menace to the household, for if it occurs the house the food may be affected, and if outside it may ontaminate the water supply. When these evils arise insects and ts are attracted and they carry upon their bodies and feet the erms of disease. Sewer gas may make its way into dwelling ouses through defective plumbing, and it becomes a serious mence to food supplies and, therefore, disturbing to nutrition.

The layman should have at least a superficial knowledge of lumbing that he may be able to discuss sanitary problems with he city engineer or plumbing inspector.[52]

The regulation of present day plumbing is based on the police ower of government, which should adhere to the principle that overnment has the right to provide for the safety, health, and norals of its peoples. Plumbing codes should be designed to proect the health, welfare, and comfort of the public, and the latter hould demand that these provisions be enforced. Prescribed ws are now as diversified as human emotions. There is a tendncy often in smaller communities, sometimes in larger ones, to eglect the enforcement of sanitary laws and regulations, which nay result from political opposition from unprincipled labor nions. Incompetent workmen may be placed on jobs for which ney have no training. Sometimes, for example, there are inances of an escape of sewer gas through mains improperly acked. Sewer gas is not strictly a gas of a chemical composition, ut air which has come in contact with decomposing organic mater. Sewer air may contain some of the gases resulting from deomposition, such as hydrogen sulphide and carbon dioxide gases, which are found in unventilated sewers or in sewer manholes. heir inhalation may overcome workmen; children playing earby are known to have suffered from headaches, nausea, and omiting. These unsanitary conditions disturb the balancing of netabolism. Bacteriologic tests have proven negative, so that one as no cause to fear infection.[52]

WATER PURIFICATION

The purification of water for drinking and for other purposes has necessarily become a man-made institution. Science has developed artificial means to do this work through slow and rapid sand filters, by chlorination, chlorine gas, ozone, the ultra-violet ray, algae control, and household filters, driven and drilled wells, pump pits, water shed protection, drinking fountains, and ice sanitation, all rendering efficient service.[52]

HOUSING AND HEALTH

Today proper housing commands all the latest appliances in sanitation and hygiene. It furnishes healthful and decent living conditions and is usually controlled by legal measures. The great changes in the present public recognition of health, sanitation, and hygiene may be contrasted with a description of a southern home following the civil war, when poverty and depression laid a heavy hand on its tenants. The great, spacious, hospitable house received its sole water supply from two uncovered cisterns situated on the roof at the rear. Each home in the neighborhood possessed a similar cistern with a depth of water dangerously low. Dust, leaves, flies, and other vermin were blown upon the surface of the water, while cats strolled melodiously around the brim and bull frogs gamboled at the bottom.[53]

In comparison, it is refreshing to see illustrations of modern housing and sanitary equipment in a five-year slum clearance project in England for the construction of houses to relieve overcrowding. In the rear of these homes are seen flower beds and grass plots with well-paved paths and benches to sit upon.[54]

SCHOOL SANITATION

Sanitation and hygiene in schools and their buildings and playgrounds proves a worth-while study. It is as much in the school as in the home that children's nutrition may be deranged. The school should not only teach the A B Cs of learning, but should include within its curriculum the principles of personal and community hygiene. It is often the school room that is the instigator of better hygiene in the home. The New York City school system in this respect, with its up-to-date buildings, its sanitary inspections, and its attending physicians and nurses, cannot be too highly praised.[55]

n smaller and poorer communities ideal school conditions do exist. It is noticeable, however, that when sufficient funds forthcoming attention is directed to improvements. Hygieni-y, the buildings should be so situated that the maximum of light may enter the classrooms, but at the same time dust, rs, and noises must be prevented or minimized. The buildings uld not be near a factory or railroad. Dangerous sources of idents should be avoided, such as deep streams, chilled winds, l deep-rutted streets. The buildings should be furnished with ean and adequate water supply, preferably from an approved blic source. Drinking water is a vital necessity and purity at source cannot be too strictly enforced. In 1925 the New Jersey te Board of Health found that more than half the water sys-ns supplying 740 rural schools were contaminated and unsuit-e for drinking purposes. The sources included wells, cisterns, l springs. There is apt to be contagion from the common nking cup, and sanitary jet fountains should be established in ir stead.

The toilets in the sanitary equipment of schools where city verage is available should be of the water-flush type, kept clean l sanitary, the seats made in U shape and of non-absorbent terial. At least one wash bowl should be handy, as well as let paper, paper towels, and soap. If there is no adequate verage in rural schools sewage disposal may be difficult. If nning water is not available the toilets had best be of the pit e.[56]

School rooms should be properly lighted by daylight, or if that mpossible, by electric illumination. Such means tend to pro-te greater study efficiency, to minimize danger, and prevent turbances of vision. On the whole, natural light obtained m a wide window spacing is preferable. The color of the ndow shades should be of light tan, buff, or yellow, and the oms done in dark orange.

One need hardly be reminded that the condition of the air in e classroom has a decided and direct bearing on the health of e pupils. Window ventilation from a revolving fan is a satis-tory method, provided the fan is large enough to force suf-ient air into the room. In the little red school house of earlier ys, excellent ventilation was afforded by the use of the jacketed ve, which combined both heating and ventilation.[57]

School seats and desks when improperly constructed and ar-nged as to height and position have caused body deformities. rrect posture therefore is impossible with faulty construction d incorrect position of the seat. In rural schoolrooms desks are

often too high, or the seats either too high or too low. It follows that the feet must either dangle in mid air or be cramped in an unnatural position under the desk. Eye affections are the common result of books being held too close to the eyes, tending in their wake to upset normal metabolism. In the past little heed was given by physicians to proper posture in school rooms, but now specialists are not only directing their attention to proper seating but also to the treatment of abnormal postural conditions.[58]

NATIONAL HEALTH

Modern sanitary measures on this side of the water have, in general, followed those in Europe, and today the planning of model houses for the working class in England, Europe, and America is a great advance over former days. One feels at times that progress in sanitary science has been extremely slow, but at least one finds a decided contrast to that of the ancients, particularly in the lowering of the death rate. The paving of streets has greatly improved and houses are now constructed to conform with newly acquired scientific discoveries. Ventilation is progressively better in houses, offices, hospitals, and prisons. Moreover, more attention is given to the isolation of the ill and to the protection of the well and to the recognition of the evil consequences of child labor, and there has come about an awakening sense of service in maintaining public as well as private health. This betterment is due largely to the advances in medical and surgical knowledge, especially along the lines of preventive medicine.

Progress has been steady in the improvement of municipal water and food supplies and in their closer inspection. Cleaner streets and the isolation and modern treatment of infectious diseases, additional public parks and play grounds have marked a steady but all too slow progress in municipal hygiene. Other evidences of modern benefits are the marked reduction in sick and death rates due to the control of infectious diseases, and there is a gradual increase in the average expectancy of life where prophylactic and sanitary work is being done. There is, however, still much to be done. Tuberculosis, for instance, is constantly making unnecessary inroads on health and longevity. In the far away countries of the world plagues in one form or another threaten, establishing high infant and child mortality rates. Pneumonia is still a problem and small pox continues to raise its malevolent head.[51]

PSYCHIC ENVIRONMENT

sychic stimuli are just as significant as the physical in the ncing of metabolism. Usually they are not as strongly empha-l, yet they tend to harmonize nutrition and physical environ-tal factors through the subtleties and niceties of the emotions. child's brain in the developmental stage is more susceptible psychic impressions than is a film plate to physical counter s, for in addition to receiving impressions it possesses the er of reason. The influence of environmental stimuli upon psyche may be good or bad, weak or powerful. Emotionalism upon metabolism, at one time increasing its rate, at another e depressing it.

n the growing child, particularly during adolescence, pro-ged emotional excitement may so affect metabolism that ntal and physical development may be severely retarded. h mental excitement is often observed in religious enthusi-s demonstrated at camp meetings and religious revivals. On other hand, school at too early an age is an emotional de-ssant, and rounded shoulders, pasty faces, and a laborious ffle are often the fruits. A misunderstanding of the child's ds in mental and physical progress may add fuel to this de-ssion, for it is in the growth period that both physical and chic stimuli are so impressive.

t is well known that at birth the child's brain is morphologi-y and functionally the most immature of all the great body ans.

rom birth to the age of seven it develops enormously in ght, structure, and function; and then slowly increases in ght up to eighteen years. Unfortunately, the increase in func-n does not keep pace with the increase in weight. The nervous em during this intermission is undeveloped but is exceedingly sitive to psychic impressions, and it is often during these rs that criminals of both sexes develop. The metabolism of normal undeveloped nerve cells must be at once rapid but v enough to ensure adequate material for growth and devel-nent. During these formative years the individual cells of brain are distinct and separate from each other. They must t undergo a process of elaboration; they must bud out and w. It stands to reason that within this developing period the in cannot be burdened with mental tasks of one kind or other, particularly with those in which it finds no interest attraction.

Public school for children at the age of five or six is unthinkable, for the brain is in a sense dormant, while the body hungers for sunshine, fresh air, and physical activity. Children forced to attend school at even six years of age, and compelled to sit still for long periods of time, are quite incapable of absorbing the lessons and quite unmindful of the advantages of an education. The kindergarten at seven and the public school at eight years result in mental and physical growth which is visible to all.

It is usually agreed that the most important period of the child's life lies within the first eight years, for it is within this period that the seeds are planted for mental and physical health, for happiness and for longevity. The child's emotional nature cannot adequately develop biologically in the schoolroom during too-early years, if his natural exuberance is thwarted. During the formative years children bound for future greatness are often backward in learning; and the biographies and autobiographies of brilliant men and women often attest this fact. The earlier the imperfectly developed nervous system is subjected to undue strain, the sooner it becomes dull and less plastic, but the less the child is restricted the better does the nervous system retain its sensitive receptivity and the more rapidly mental growth and development go forward. Early school age with impersonal tasks tends to destroy that which in years to come makes the master—the child's ego. Possibly the effects of psychic stimuli on the child's growth and development cannot be more dramatically portrayed than by an illustration of the influence of music and color on metabolism.[59]

SOUND (MUSIC)

In order to understand the effects of music upon the child's organism, we must commence at the beginning and focus our attention on sound and on its meaning. If the rhythmic vibrations of bodies which are the material basis of sound are to excite the ends of nerve fibres we must make use of the principle of resonance. If, for example, there are a series of strings in regular order as regards the period of vibration, sound waves of a particular period will affect some of these strings and set them in vibration, while other strings will be affected by other waves. Indeed, a biologic structure of this nature is supposed to exist in the cochlea of the internal ear and is commonly known as the basilar membrane. This membrane is capable of periodic vibration in one direction only. The nerve fibres within the cochlea, by means of a complex structure (the organ of Corti), are stimu-

d when that particular element of the basilar membrane ch resonates to a given note is set in vibration by it. There n consequence an impulse to the cerebral nerve centres, which intimately connected with the central nervous system and its sidiary, the sympathetic. When sound waves, whatever may their form, follow each other with regularity, with a definite iod or rhythm, a musical sound is perceived, provided the thm is maintained for a number of vibrations. This regularity periodicity of the sound waves may be considered as the un-lying cause of musical sounds. Noises or non-musical sounds nonperiodic vibrations and may result from a mixture of very rt as well as different rhythmic vibrations.

All the simple vibrations of which each component tone is nposed are combined to form a compound wave-music, har-ny. In order to understand the meaning of discord, of much the present day jazz, let us consider two tuning forks vibrating e at 100, the other at 110; the two combined then will give beats per second. As the number of beats increases, the ect on the ear becomes more and more disagreeable, and most ectionable when the beats recur at about thirty-three times second. While the individual beats are not distinguishable, we speak of the sound as discordant.

The pitch of a tone, therefore, depends on the frequency of e vibrations. As the speed of rotation increases, as for instance it of a klaxon horn, there is an increase in the number of im-lses; the note appears to be rising. But since sounds of high d low pitch travel with the same speed, the distance between e waves diminishes as the number of impulses per second in-eases. The child's ear, and of course to a lesser extent that of e infant, is unable to perceive tones the pitch of which falls ove or below certain fairly well defined limits. If, then, the mber of vibrations is less than about thirty per second no usical tone is produced. When, on the other hand, the number increased to forty per second the child is probably able to ap-eciate a pitch in the note produced. As the number of vibra-ons per second is increased the note rises steadily without a eak until 15,000 vibrations per second are approached. Above is it is impossible to perceive any note whatsoever. For music either the lowest nor the highest tones are used, for between and 4,800 vibrations per second, or seven octaves are em-oyed. The quality or timbre of a note is important also. The me note may be sounded on different musical instruments, yet e writer has known a child to verify the instrument used, in

spite of the fact that different instruments use different tones, some higher overtones, and some lower overtones.

LIGHT

In keeping with the details essential to an understanding of the impression of music on the mind are the similar beginnings in the treatment of color. Light, like sound, is a form of energy, and consists of electromagnetic waves which travel with a velocity of 184,000 miles per second through the ether. One characteristic property of light is its intensity, the other is its wave length, all light waves varying greatly in length. Thus, those falling between certain limits are able to stimulate the eye and are therefore called visual rays. These are the rays in which we are directly interested. The rays of a beam of light arrange themselves according to their wave length; the rays of the longest wave length are red, but as the wave length becomes shorter the color gradually changes to orange, then to yellow, then to green, then to blue-green, to blue, and last to violet; at which length, the wave being so short, visibility ends. Above the red waves in length are the infra or heat rays and below the violet, the invisible, or actinic rays; neither of these, however, coming within the scope of this discussion. The colors of the spectrum have important properties which form the foundation of color mixture, color harmony. These spectrum colors have another important property, in that if red and yellow be combined orange, an intermediate color, is produced. If red and green are mixed there results yellow, another intermediate color. Light possesses three properties; color, saturation, and intensity, the latter depending upon the amplitude of waves. For instance, the intensity of the mixture produced by red, green, and violet can be readily adjusted by varying the intensity of these three rays, thus matching every shade and color, when a certain color, let us say, might be desired for that particular child under observation. Color itself is due to some differences in the behavior of the medium substance toward the various rays of the spectrum. Color, of course, may be also produced by fluorescence and by phosphorescence, with which, however, we have nothing to do. Furthermore, it should be understood that the heat rays play no part in vision and often are known to have done harm, as may be seen on the unshaded seashore during a cloudless, sunshiny day in summer.

The energy of the spectrum is present in the greatest amount at the red end and least at the violet, and the origin of this energy is heat at its source. The intensity and wave lengths of the many

rs must, we assume, make some, as yet, not thoroughly un-
tood impression on the brain of the child, for these colors
be excitant or sedative, and react in this manner upon the
ral nervous system. So, too, can we postulate that the presence
n undesired, distasteful, or offensive color may change the
l's mood from contentment to discontent, from happiness to
ery; all of which affects his nutrition. A physical change
s place when the retina is stimulated by light or color, namely,
electrical response somewhat similar in character to the cur-
of action in the nerve. With light of any one color there is
eometric use of intensity and a color with intensity causes an
hmetical increase in the electrical current to the retina and
n it to the brain. Both eyes in the child are not equally
ptable to the same color; for with colored rays of apparent
al intensity, for instance, the yellow rays are said to give a
ger current in the light adapted eye and green rays in the
k adapted.

he light rays, then, which enter the eye stimulate the physio-
c processes of vision which result in the sensations of bright-
s and color. Vision, therefore, involves the physical stimuli,
physiologic processes, and psychologic sensations, and can be
led, we believe, to those other environmental stimuli which
rt such an influence upon metabolism in childhood. The
siologic must be separated from the psychologic elements,
vever, and visual experiences, though very complex, touch
on the whole personality of the child. The effects of these
ual stimuli, for instance, can be observed upon blood pressure,
on muscular and mental nervous activity, upon the child's
od, and in many other ways.

SOUND AND LIGHT ASSOCIATED

Music is certainly more impressive reflexly upon the child's
ganism than is color. To understand this it is only necessary
study the physical properties of music. Sound is propagated
waves consisting of alternate compressions and rarefactions
ich travel through the medium. Since sound is a form of
ve motion it exhibits many of the properties which are found
the case of light, namely reflection, refraction, and diffraction.
ving to the longer wave lengths of sound waves, as compared
th those of light, the effects of diffraction are relatively of
eater importance. As compared with light, sound does not
m sharp shadows, but it can bend around obstacles, which
uld be impossible if sound were of shorter wavelengths.

Sounds, too, unlike light, are divided arbitrarily into tones and noises, the former pleasant, the latter unpleasant. Music consists of tones and chords. Sound waves are usually found to be of a highly complicated nature, and only when a pure tone is a source of sound such as a weakly sounding tuning fork, is the sound wave regular in form. With light, loudness or intensity is found to depend on amplitude, while the pitch of sound depends on the wave length; the short waves having a high pitch, the long waves having a low pitch.

MUSIC SELECTION

In the selection of certain musical compositions for a particular infant or child, we are largely governed by age, race, the condition of the hearing apparatus and of the sound mechanism, by the temperament, the mood, and the personal likes and dislikes of the child, by his environment, and by many other factors. Children of certain races and of certain environments tend to understand and to enjoy the musical tones of those instruments and of those people among which and among whom they live. The French, Italian, and in lesser vein, the English speaking children tend to enjoy the labially expressed musical tones of their own environment, while on the other hand, the German, Scandinavian, Russian, and other Slavic children naturally prefer the guttural tones of their own nations.

No one in his wildest flights of fancy can imagine an infant appreciating the complicated themes of the musical compositions of the great masters. Its auditory apparatus and its hearing mechanism are so undeveloped and its nerve centres so immature that this is impossible. When this apparatus and this mechanism are malformed and abnormal many of the normal attributes of their physiological growth are wholly or partially lacking. With the gradual growth of a normal hearing apparatus there comes an increasing understanding of many simple and of many mixed tones. In the early weeks of infancy, some of us have felt that there may be some response to a low pitched, slow, vibrating note struck on some musical instruments, such as on a tuning fork, on a guitar, or perhaps on a violin.

It is highly probable, too, that an infant of a very gifted musical family may have a true potentiality, inherited from past generations, for a certain note or for certain notes. Under such endowed conditions, this infant will make quicker progress in a musical education than one not so favored. This tone potential-

may develop later into genius under proper and stimulating
ironment, but a child not so hereditarily inspired, in spite
the finest musical environment, may become but a lover of
sic.

Thus it would seem that certain infants, particularly in early
e, respond to some note or notes, pure in character, of low
ch, and of slow vibration, peculiarly fitting to their individual
eds. This holds good not only of a struck string of a musical
trument, but also of the tones of the human voice. Note the
nple, pure, low pitched and slow vibrating tones, the soothing
oning of the negro mammy to lull the baby to sleep or to
othe its irritability so that it may suckle. Recall, too, the
dle songs of the European peasantry sung in a similar vein.
l pediatricians have seen such pictures. In the child whose
ditory faculties are more highly developed the scene changes,
re and simple tones are exchanged for mixed ones, tone com-
nations.

In the more gifted children a so-called musical ear is developed.
ch children respond when in normal health, or even when
disposed, to a higher type of music, often classical in character;
e works, for example, of Mozart, Beethoven, Liszt, Chopin,
d others; and among these are found gems of undulating
ythm. To a child less gifted, ballads and negro spirituals often
peal, and the Hawaiian melodies are favored alike by all chil-
en. At one time one form of music may appeal, at another
me quite a different form. What pediatrist has not repeatedly
en astonished at the phenomenon of an apathetic, sickly, whin-
g child suddenly changing his mood, beginning to eat and
sleep better from the rousing inspiration of a Sousa military
arch or from the lilting strains of *My Old Kentucky Home?*
ll of this is of course brought about by the right music rightly
resented, and such possibilities cannot take place from unde-
rable music, even when rightly or wrongly presented.

Organized music in the treatment of disease implies that the
usic must have certain well defined qualities to harmonize with
rtain characteristics of the individual child. The words of a
ong, the character of its composition, its tone, color, rhythm,
nd tone repetition, all must be taken into consideration, all must
e combined in such a way that the song soothes or stimulates
ne child to new joy and happiness. Indeed, the strong emo-
onal influence of music on healthy children, as well as on those
ho are ill, has been recognized for a long time. Through
usic skillfully selected, healthful emotions have been aroused,

the appetite stimulated, and metabolism increased. Martial music, to a depressed, lethargic child suffering from malnutrition of one form or another, often tends to develop increased ambition and greater mental and physical activity. Note the faces and movements of the youngsters, of whatever walk in life, of whatever condition of health, when the band strikes up a military march in a parade. Such music often arouses them to uncommon feats of energetic muscular action. Napoleon once said that the weird and barbaric tones of the Cossack regiments infuriated them so intensely that they wiped out the cream of the French troops. Congreve felt the power of music so strongly that he expressed its power in those lines:—

> Music hath charms to soothe the savage breast,
> To soften rocks, or bend a knotted oak.

Yes, music hath charms to soothe a savage breast, as well as to stimulate the gastric juice and brighten the jaded nerve force.

THE RHYTHMIC SENSE

The esthetic part of the child's environment, the rhythmic sense, so necessary to his happiness, is fostered through the selection of artistic dances, beautiful color surroundings, and through music appropriate to the type and style of the dance. The importance of this rhythmic sense in the child's mental life is properly recognized by men of science as of great value. The consciousness of rhythm and of harmony is formed through the cooperation of the labyrinth of the internal ear, of the cerebellum, of the spinal cord, and of the medulla oblongata with the cortical portion of the brain. These control posture and body movements. Thus music plays an important part and children should be instructed in physical exercises and in plastic dancing to music in order to develop rhythmic bodily movements, as well as to place the body under more strictly conscious control of the brain.

THE THERAPEUTIC USE OF MUSIC

Many of the ancient as well as modern thinkers who have devoted their attention to the physical and mental wants of man, have repeatedly recognized music as a therapeutic agent of the greatest value, and have warmly advocated its use in the cure of disease. Bible students will remember the word, "When the evil spirit from God was upon Saul, then David took a harp and

ayed with his hands. So Saul was refreshed and was well and e evil spirit departed from him." The brain and body of e child are so closely allied, the organs and tissues of his body intimately and delicately associated, that the environmental ctors which affect the one will also just as surely affect the her. Voltaire satirically observed that people were in the habit going to the opera in order to digest. When the ancients rescribed a soothing tune as the proper accompaniment of any rmal meal they were acting upon the result of observations nd of feeling which had a strong basis in physiology and psyology.

After an active day in school and at play, after a simple meal nd before going to an early bed, the modern child usually enys tuning in on the radio with a station broadcasting melodies nd songs of a pleasing nature, provided the former are well layed and the latter well sung. Such music is often conducive early and refreshing sleep. Amid the slums, tenements, and lth ridden spots in the large cities, the little children dancing to e rhythmic musical strains of a barrel organ or to the wailings f a street orchestra are an inspiring sight, for instinctively they re acquiring body rhythm, keener appetites, and keener mental lertness.

The primitive physician in all parts of the world today perorms his cures with the aid of a musical accompaniment. As nother language makes another man, even so does the scientific tudy of many emotional rites among savages intended for the ll tend to make the physician a broader minded man. Herdon nd Gibbon have chronicled the amazing benefits of medical ncantations upon the ill Brazilian Indians, and Wallaschek gives umerous examples of the value of music among the Africans, Australians, and among the North American Indians. Highly ifted Indian tribes, among which may be named the Sioux, ven particularize in their musical selections intended for their ick members. These songs and chants are used in cooperation vith medicinal herbs, and each disease, let us say headache or onsumption or heart disease, etc., has its own appropriate tunes o bolster up the individual. Wanderings through the literature of medical psychology reveal numerous cures through music. Ethnologists have shown that whenever a powerful emotional effect among our tree climbing ancestors was desired, particularly in the treatment of disease, music was made use of.

Having generalized a bit upon the power of music in the ills of mankind, it may be of interest to particularize many instances of this power on children, occurring in the clinical practice of

numerous physicians, many of whom are well known. In 1896, for instance, Dr. Beschinsky, a Russian physician, reported the cure of a three year old child of sleeplessness and night terrors through the medium of Chopin's waltzes, at first played nightly and then afterward at intervals of two, four, to six nights, etc. Dr. Fournier Pescay, to cure the insomnia of his little son, played soothing music on the flute. Dr. Bourdois de la Mothe attended a young girl who had suffered for eighteen days of a high fever; her pulse was weak, and her extremities were cold. After forty minutes of harp music the breathing improved, the extremities became warmer, the pulse grew stronger, speech returned, and convalescence began. In our early days of medicine and even in recent times, so much good has been and is being abscribed to drugs in the diseases of infancy and childhood, that to assert one's belief in the greater value of nutrition and of its environmental agencies would almost tend to brand one a heretic.

THE EMOTIONALLY UNSTABLE

If music furnishes such a strong impression upon the lives of normal children, those children whose brain and body are so well balanced that with the growth of the organism there is an expansion of emotionalism under control, what must be its value to the emotionally unstable. The background of this emotional instability in children usually rests upon a more or less unsatisfactory heredity, or possibly upon a satisfactory one thwarted by faulty environmental factors. The value of music upon the emotionally unstable may be of greater importance than that upon the emotionally stable, and many of these unfortunates fall under the eyes of the pediatrician. Clinical observation warrants us in believing that such children react more dramatically and more profoundly than do normal children, particularly to certain tones and chords which seem to harmonize with their own emotional states.

Frankwood E. Williams of the National Committee of Mental Hygiene has pointed out the alarming fact that from every 7,000 children born in the United States each year, 269 of them will become definitely mentally diseased in the course of their lives. This provides a very great sociologic and economic loss to the city, state, and country. Indeed the physical and mental breakdowns of later years have their origin, in many cases, not only in the pathogenic, immature, and in the ill growing organs of the child, but also in the badly regulated environmental life of infancy and childhood. Which phenomenon precedes the

er is always a question for debate. Williams adds, to illus-e the last paragraph, that in the year 1923, 50,000 Americans e admitted as new patients in the mental hospitals of the ted States: and this number does not include the readmissions. king forward, this means that 250,000 people carrying the dens of life today will break down mentally under the load hin five years, and also that one half million of men and nen will be registered in the mental hospitals alone as new ents within ten years, at an increasing rate of admission each r. Of all the factors which contribute to the flood of human later in life, the psychologic stands out clearly. With the erfectly balanced brain and body there is found unstable otionalism, immaturity, and instability.

IUSIC IN THE EMOTIONAL AND INTELLECTUAL LIFE

The two great phases of the child's normal psychologic life the emotional and the intellectual, and both of these often ecognized forces represent the two sides of his mentality, so ely interwoven that the one strongly affects the other. It is ugh to point out the fact that in a well organized brain and y there is normal desire for intellectual advance as well as a biologic control of the emotional centres. In truth, the undwork of real civilization lies not only in a greater knowl-e of children's nutrition, but also in the use and control of r intellectual powers, as well as to an understanding of their otional faculties. In the recent past, and current at times ay, there appears to be a tendency to force upon children at may be termed a standardized education and to disparage ewhat the safety valve of natural impulses. There can be no ntal health apart from body health and the mentally healthy d may be said to be one whose power of resistance is in ilibrium with both the internal and external destructive ncies preying upon his well being. On the other hand, the ntally diseased child is one whose mental processes, and often physical, do not harmonize. Such unfortunates come into flict with other children more naturally balanced and find cord. The pediatrician sees today a struggle between the very mitive fundamental instincts of the child revealing themselves ough emotional demands such as "I will" or "I will not" and present day conditions and social urgencies of a changing ety. It is for such obscure children that music offers such endid possibilities.

We do not desire to discuss psychopathic children, for these rightly fall into other hands, but the many minor mental upsets from many causes do assuredly fall within the province of the pediatrician, for such emotional disturbances commonly play havoc with the children's nervous and digestive systems. Pediatric Utopia is the balance between the child's physical, intellectual, and emotional life, and the problem of the pediatrician is to harmonize all these factors.

A master craftsman in pediatrics employs music and color. The art of music in educating the intellect and the emotions is not of recent growth. Back in the sixth century before Christ, Pythagoras expressed his belief that music was the expression of unity of all that was created. His little band of followers rose at an early hour and sang songs. They searched, too, for harmonies and rhythms that, as they expressed it, would subdue any tendency to jealousy, pride, excess of appetite, and to angry feeling. Music, paradoxically, does to the child of abnormal mind practically what it does to the well balanced one; it displaces the gloom of morbid isolation and creates a direct, pleasurable, congenial, and beautiful environment in tones. It gives also to the normal child a sense of esthetic satisfaction.

Physiologically, music not only tends to stimulate the appetite juice and to foster an improved metabolism, but it reacts, through the nerve centres, on the senses, as well as on organic function, stimulating muscle tone and a stronger heart action. The therapeutic values of music are all relative, depending on many circumstances, for that particular child under treatment, on his music tone and rhythm urge, on his mood, his age, his race, and on his environment. The sonorous cadences of African drums, pleasing to an enchanted black child, might to the ears of the Occidental ring discordant and inharmonious. For songs and music must be kept consistently within the range of the child's experience and THREE LITTLE KITTENS for a very young child corresponds to FROM THE LAND OF THE SKY BLUE WATER for an older one; the former child having seen a kitten but probably not at all understanding the meaning of "sky blue water." A story song, too, is to the child refreshing, inspiring, interesting, soothing, and often creative, while every mother knows the therapeutic effects of lullabies.[2]

COLOR

When we approach the subject of color impression upon the child's nutritional life we do so with enthusiasm, yet with trepi-

on. For this great field for research and clinical observation been largely untilled, possibly due to the fact that light ations do not tend to make such a marked impression upon nerve centers as do those of sound. Possibly to many the that color may have great value as an environmental agency ne nutrition of infants and children, may seem far fetched. critics point to the fact that the normal fatigued, hungry, hirsty child, in spite of his harmonious color surroundings hich he takes little heed, craves less esthetic, and more matestic refreshment; namely, rest, food, and drink. He is, how-, more influenced by these harmonious surroundings than mentally and physically unbalanced child would be under same conditions. As the mental impressions change with age, perament, habit, mood, and state of health, the question of lor or color blend becomes one of more detailed study than ents have heretofore granted it. Therefore the scientific ction of color or color combinations with which we surround dren may go a long way even in undeveloped children to blish a balance necessary to both the mental and physical being.

omparatively little attention has been given to the study of r, color combination, color harmony, in respect to their etic influences upon the health and happiness even of the lt; while much less has been spent upon identical conditions hildhood and in infancy. Much more has been accomplished elation to music. This is undoubtedly because of the fact the hearing is more acute than sight, or perhaps sound imsions are more forcible. Music, too, through years of train- is better understood and interpreted than is color. One not but believe that were color and color harmony taught in y childhood perhaps almost the same results would be eved. At the same time we must realize, says Luckiesh, that r experiences are very intricate and are often hard to inter- at present, perhaps because of scanty knowledge of the nents and processes involved in the emotional appeal of rs, as well as our inability to understand and correlate the ous factors. Color in a broad sense includes light and shade is synonymous with light. Colors record their impressions n the human organism in much the same way as does sound, each child forms different impressions of them, and such ressions are often found to be closely dependent upon former ciations which, to a certain degree, prove individualistic and ally date from past experiences. Colors, then, like sounds

and their tone effects, have some definite attribute universally recognized.

PHYSIOLOGIC AND PSYCHOLOGIC EFFECTS

It is unfortunate that the recorded physiologic and psychologic effects resulting from the influence of color on the child's organism are so meagre, and have been so little worked out. However, a few experiments for illustration can be cited. Fére studied the effect of colored light upon muscular activity, measured dynometrically, under ordinary light. This muscular activity was found to be twenty-three units on an empirical scale. It increased to twenty-four units for blue light, to twenty-eight for green, to thirty for yellow, and thirty-five and forty-two units, respectively, for the orange and the red light. Thus one can realize the more stimulating effects of the "warmer" colors. Pressey, who studied the effects of red, green, yellow, blue, and white light, all of equal intensity, found that after subjecting a person to a given color for five minutes, he could detect differences in the effects of the various colors on memory, on mental work, and the like. Pressey found also that the activity of the mental processes of one subject might take twenty percent more time than that of another, under the influence of the same color; while in quite another subject the memory work in particular was found to show marked improvement under a certain colored light. All this, in our understanding, appears to show a definite relationship between colors and their impressions on the mind and consequently upon the body of the child, in relation to his mental and physical growth. So too, the arithmetical work of the child is much improved under red light, yet even here one obtains different results among different children. It is both logical and natural to assume that, other environmental conditions being equal, many of the child's activities of both mind and body would be favored by a "pleasant" color, or hindered by an "unpleasant" one. For just as certain as children have an intolerance for a certain food, so also have they an intolerance for some particular color. We may possibly say that color assumes two general positions with respect to the child's consciousness: in one the color is the focus of attention and in the other it is not, although it is somewhat influential. If, for instance, a color arrangement be so closely studied, the child's attention so closely fixed on this color scheme, the surroundings, the color environment, if particularly unusual, will have no appreciable influence upon his mind. On the other hand, the environment may be of

ch a nature that the child is pleasantly or unpleasantly conous of it. The so-called subconscious element of the child's nd must always be considered as a more or less dormant power pable of affecting unexpected influences which modify his dgment. Thus, although the "warm" colors are predominantly mulating they may be either agreeable or disagreeable. The old" colors, too, although predominantly restful may also be reeable or disagreeable. It is probably association and approiateness which determine this agreeableness, but such condins act generally through the child's subconsciousness.

COLOR SENSE

At the present time the most complete knowledge of color fects, particularly as to their soothing and stimulating qualis in rooms and in homes, which tend to react upon the physil condition of the child, seems to spring to some extent from e observation of present day hospital wards. Compared with me of the many other environmental stimuli which act more rectly and actively upon the biologic cell, the color rays exert eir influences more passively and more indirectly through the mpathetic nervous system.

The sense of sight deals with light, the hearing mechanism ith sound. Light, however, is responsible for perhaps sixty ercent of all the impressions upon the mind. Primarily the eye es color only, which means that all ideas gained through the nse of sight depend on certain color relationships. Space does ot permit us to analyze the normal consciousness of a child, hich tends to reveal two distinct types of visual sensations, the chromatic and the chromatic. It is enough to say that within e child's brain there is present what may be called a color sense, nd the mind experiences a feeling of pleasure when it meets a olor harmonious with it. An uncommon color would not give is same sense of pleasure. Therefore the effects of both these pposites act in some undiscovered way upon the emotional enters, and much as we believe in a nerve center as sound ansformer, there may exist also a nerve center color analyzer. f then the normal child is susceptible to color impression, as an be readily observed, how much more so is the convalescent r sick child susceptible to such impressions in its weakened ate of health. A color autosuggestion, as it were, might be ossible. Each child reacts individually to a color or to colors nd the probable capacity of any child for any color is unknown. n the very young a single color, a single object, a single tone,

or a single food produces a more vivid impression upon the mind than any combination of these factors.

COLOR COMBINATIONS

In demonstrating the effects of colors and their combinations, some of the characteristics of colors and of their relationship to each other might well be pointed out. For instance, red is known as an individual color. Yet this color is often called red when it contains a small blue component, and sometimes, too, a color is called blue or violet when it contains only a small red component. Included under the term yellow also are many closely allied color names, such as orange, gold, saffron, citron, brown, etc. Many of these browns border on red, some on yellow shades, while still others are close to black. Green is a distinct color, yet it includes the yellow greens, blue-greens, and the olive.

COLOR PREFERENCES

Color preferences may be divided into two classes:—first, the preference of colors influenced as little as possible by association, environment, and other factors, and second, their preference as affected by the ordinary environment of everyday life. Children of the first class choose colors for color's sake amid neutral or uninteresting environment. Those of the second class, however, observe the colors used under various conditions, such as decoration, in dress, in birds, and in advertising, etc., especially as the warmer shades are used more generally for these purposes. As children grow older in more or less cultural surroundings their tastes run more to tints and shades rather than to pure colors. But in illness, and often in health; do we desire an emphatic, strong reaction, we then choose the purer colors. Some insight into the child's individual nature, perhaps a certain degree of refinement, can be interpreted by observing the colors chosen by such children.

The source of all color lies in nature, yet she in her splendor oddly uses but few pure colors. It is only through environmental stimuli that the mind and body of the child reach their highest development. Therefore it is possible for every visual impression to be the cause of a mental reaction, although it is obvious that the effectiveness of these visual stimuli is dependent largely upon the state of intellectual development of the child or his ability to observe and react.

'sychologically, the potentialities of color in relation to chil-
en are sometimes complicated by past experiences, sometimes
superstitions, habits, etc., and may also be influenced by
tain inherited recessive or dormant traits influencing organic
nction. Closely linked to this heredity are certain emotional
d sentimental attitudes which effect many differences as re-
rds color choice.

The variety of brightness and of color sensations depends
on the state of the child's mental growth. The so-called warm
ors, red and orange-yellow, are both stimulating and exciting
varying degrees, the maximum being for red and less for
llow. Different colors may be said to arouse various moods
d affections, blue tends to produce a grave mood, violet a
emn one. Upon children of finer sensibilities these colors
y work powerfully. As has been said, children may sometime
joy color independently of design or association. Perhaps
me of that pleasure may be dependent upon the special rela-
ns of various colors viewed simultaneously, a color harmony.
t when certain color combinations are pleasing or displeasing
still unknown. It may have to do with environment, training,
nperament, and heredity. A color may attract the attention of
e child whether it is pleasing or displeasing, but the power of
raction is doubtless proportional to the degree of pleasantness
unpleasantness. Again, too, we find that contrast in tone and
ightness is a strong color factor in children; as, for instance,
e attraction of black stockings with white or red stripes on
em.

The time length of color exposure also is not to be minimized
childhood. Colors in the child's early years may make a more
rid impression when seen for a short time only. Seen over any
preciable length of time, such colors make a fainter impression
d their image is less acute. On the other hand, with comple-
entary colors of a very striking character, a longer exposure
nds in the esthetic older child to give a better judgment of
em. Often the pediatrician may be criticized for trying to
rmonize colors in a child's playroom, bedroom, or playground.
udy Nature, his critics say, for she has pure and combined
lor schemes in perfection. But has she? Possibly on account
unperfected standards or faulty training, or possibly of certain
vironmental conditions, etc., we think she has so often no
lor harmony or perfect blending at all. The colors blue and
een, for example, which even untutored children do not con-
ler harmonious, are very conspicuous in combination in nature;
for instance the blue sky and the green vegetation underneath.

However, this much may be said in explanation; though the sky is many times brighter than the green foliage underneath, there is only a tint of blue, and that a very light one. This blue brightness, too, tends to throw the green vegetation into deeper shades.

EFFECTS OF COLORS IN CHILDHOOD

For years colors have been commonly spoken of as stimulating or sedative, active or passive, warm or cold, depending upon their position on the light scale and on their effects upon the person. Red is an independent color, independent of other colors. It is at its best when its hue tends toward orange or towards violet-red, a color decidedly warm, aggressive, and energetic, combining the stimulating and forceful impressions of heat, passion, fire, etc. A child exposed to the influence of a saturated red might show in time an improved musculature. When used for the sickroom or even for the nursery, red should never be employed in its saturated form except in very small shadowed areas, and is then better balanced by other hues, the so-called intermediary ones. Mixed with other colors it gives the feeling of warmth. Combined with a white lead pigment base, in proper admixture with yellow and with other tints, it forms a strong red side wall color in rooms, mildly stimulating, when the child is low spirited, depressed, and unhappy. Yellow is the tone nearest in appearance to natural sunlight and it carries with it a warm brightness and has a serene, softly exciting character. Its most striking appeal to the child lies, without doubt, in its high luminosity, associating itself in his mind with the cheerful life-giving qualities of the sun; the mind thereby being pleasantly stimulated. This color also can be reduced with white lead tinted to a buff by the addition of red and black, or deepened to a tan-orange. A combination of red and yellow represents the most active color combination, but it conveys a restless, forceful impression and should be avoided in the sick room at least.

If yellow and blue are combined in proper pigment proportion so that neither predominates the color known as green is the result. This admixture happily combines the tranquillizing and subduing properties of the blue with the warm cheerfulness of the yellow. It is especially valuable, says Paul, as a room color scheme where fretful infants and children are confined, and its restful qualities seem to quiet them. As yellow is invariably associated in the mind of the child with light, so it may be said

t blue brings with it a feeling of darkness. In its saturated e it is colder than all the other hues. A child's playroom done irely in this color would appear larger than formerly, but at same time it would be empty, formal, uninviting, and cold. is color, too, has a peculiar and almost indescribable effect the eye. As a hue it is powerful, but on the negative side of color scale, and in its highest saturation is, as it were, a nulating negation. Its appearance, then, is a kind of subtle ntradiction between excitement and repose. On the whole, it ds to have a depressing influence and would seem to be ex- mely unsuited in great proportion in any home where there infants and children.

Vhen we turn from the chromatic colors to the achromatic, ose termed colorless, we must consider the intermediate steps m white to black, or the greys. Among the greys are found merous color variations. Those approaching the medium grey, utral in fact, are distinctly restful, for they are neither warm r cold, stimulating nor depressing, and can be used for many corative purposes and for the child's clothing. In the ordinary om which receives a normal amount of natural illumination, grey having a light refraction factor of perhaps forty to forty- e percent would appear pleasing and comfortable. However, ne of the rooms in the very large cities do not receive any- here near this amount of light, while others in the country ve a superabundance of it. A grey must be lightened or rkened to suit the requirements of the room or of the child. hen this suitable grey has been chosen as a base, let us say, any color effects may be worked out by the addition of small nounts of certain hues. These greys may be tinted slightly with een, or with a touch of red, when they reflect a sense of rmth.[6]

It may be of interest to give a thought to the color scheme the dining room, for it is not mere imagination to believe at in the harmonious tinting of this room the appetite of the ild may be stimulated and the sparkling flow of his chitter- atter may be increased. Favoring this color harmony, one may ention, for instance, dull crimson panels, shaded rose tints to rmonize, and a little old gold added here and there, as well some yellow and its related shades. In the other rooms of the ouse, other colors and tints may be found helpful in har- onizing with the color sense of the different members of the mily. Indeed, beside the colors already enumerated, we may ention the modifications of others suitable in decorating the omes to suit the tastes of the family; straw color, citron, fawn,

pale stone, café au lait, lavender, pale cream, buff, French grey, cream, beige, light brown, tan, putty, pastel grey, light blue, dove grey, pea green, ivory, and pearl grey. Pediatrists may well give heed to some such colors in the decoration of their consultation and treatment rooms.

In our own experience, we have found many children very sensitive to colors in their surroundings, others less so, while still others seem to show very little or no reaction to them. Yet retinal activity is perhaps more intimately related to the mental and physical well being of children than many of us suppose; and since the atmosphere of a room is created largely by its color, a little serious thought given to color selection may establish a cheerful environment. This also holds good for the child's clothing, tableware, pictures, toys, etc. But beyond all the artificial color schemes of man, Nature has ever been far in advance, her colors pure, their harmonies exquisite.

From the time the child wakes in the morning until he goes to bed in the evening, he is surrounded by an ever changing display of color. Usually no notice is taken of this display unless it is brought to the child's attention; such as a brilliant sunset, a rainbow, a field of daisies or buttercups, the brilliant coloring of the trees in autumn, of the barnyard fowl, or of the peacock, or of butterflies.

COLOR EXPERIMENTS ON INFANTS AND CHILDREN

Now that color and color combinations have been more or less thoroughly discussed in childhood generally, it may be of interest to focus our attention upon experiments conducted on certain infants. Here our conclusions are even less standardized and conclusive than in childhood. The reasons for this are not hard to understand. The infant at birth, and for some time after, is physically and mentally helpless, the body powerless, the senses not awakened, and the brain and its functioning power immature. In fact the brain at birth is morphologically and functionally the most immature of the great body organs. With the growth of the special senses, psychic impressions become more marked and varied, resulting in adequate responses. The child progresses to the realization and understanding of his ideas and sensations and to the perception of tangible visible objects, but the advancement is slow. For the infant to be impressed by music or by color it must have memory and association, all of which in its extreme youth it has not. Thus it comes about that music and color in their true sense are certainly not understood,

id clinical observations are in early infancy often uncertain id inconclusive. Probably some of the most important of such cent investigations are those of Baldwin, Shinn, McDougall, id Meyers. Most of these experiments were made on children etween the ages of six and twelve months. All these investigars, except perhaps Baldwin, were concerned with the colors referred by those children. Meyers found that among the chilren observed by him, yellow was preferred to white; McDougall oncluded that at the age of six months red, green, and blue were referred by one of his group of children to the grays of the me brightness and even to white; but not one of the colors sed, red, green, or blue, was particularly preferred by the reainder of the group.

In reviewing the evidence of several other investigators durng the second half year of infant life, Miss Shinn remarks that ed, yellow, and orange seem the most attractive colors, but hite she believes even more attractive. Baldwin's results showed at blue was slightly preferred to red. However, it must be said hat these experiments were all conducted at short distances rom the child's eyes, which consequently obscures the fact that t long distances red fares distinctly better than blue. Therefore, erhaps under changed conditions Baldwin's child might have ound red about as attractive as blue.

The general conclusions of all these investigators showed pracically that red and yellow were the best liked colors at this age. Valentine appears to be surer of his ground than most experienenters, for in conducting experiments on his own little son, sing the Holmgren woolen yarns, as well as the handgrasping nethods, which space forbids us to describe, he arrived at the ollowing conclusions; first that there is good evidence for beieving that at three months an infant experiences the sensations of red, yellow, brown, green, and blue. Secondly, in the case of he infant under consideration, the order of preference of colors vas as follows:—

Yellow	(white)
	(black)
Red	(brown)
	(black)
Violet	(blue)
	(green)

This order of preference seems to be determined by brightness, at least in part. It may, however, be explained by novelty or by contrast. This relative brightness is certainly, in our experi-

ence, an important factor in the answering of that question, what color does the infant like? It is rather unsafe, however, to draw inferences as to color preferences in infancy, especially if the colors used are of unequal brightness. In the testing of colors from the Holmgren wools the results showed that yellow and pink were equally bright and equivalent in brightness to a grey of say 185° white + 175° black. The green, blue, violet, red, and brown colors were also practically equal in brightness and equivalent to gray. After all, as has been suggested, is this order of preference determined by the relative powers of the various colors as stimulation to the child's vision sense? At seven months Dr. Valentine's son still liked yellow best of all, and then red and pink, while the attractiveness of white decreased, being at this period no greater than was violet or even gray.

Probably the most thorough of color tests made on children, at least in point of painstaking detail, and with the most skilfully devised apparatus, were made by Martin. Children, she finds, take great pleasure in color surroundings. Her youthful subjects were tested under conditions of light, of space, of the position of the colors, and of the distances of the children from those colors.

Two pertinent questions then seem to stand out clearly in mind at the very beginning; first, do children have a color preference? Second, what factors would warrant us in believing that the child has a sense-perception of color and of color combinations? Martin has described at great length the detailed methods of her experimentation. One hundred and seventy-seven children in all were tested for color preference—eighty-five boys ranging between the ages of seven and sixteen years, forty-one girls between eleven and thirteen years, and as well fifty-one additional children, while twenty-six additional boys and twenty additional girls between the ages of four and six years were also tested. Greater weight was placed upon the testimony of the boys, for the little girls proved to be influenced more strongly by association, by dress, and by the colors used in making themselves attractive. The suggestive influences of fashion and of the tastes of the parents also entered into the picture. The clothing of the boys made but little impression upon them except as to color schemes. However, these latter conditions did not prevail among the very young of both sexes. It was noticed, too, that the social environment for the status of the father was carefully looked into, had great influence on what might be termed the

entive idea of colors in general and on the knowledge and ue of the colors in particular.

or the success of psychologic experiments with color on chiln, the experimenter must look for all accompanying symptotic psychologic conditions apart from the child's reactions l answers. This would include mild or severe mental disbances. False conclusions may be drawn from the child's itability, his anxiety, or from the disturbing factors of strange oms and of strange people. In such exacting psychologic eximents, too, shyness, fear, and other emotions must be stilled. e sittings must be of short duration, else weariness blanks nclusions. Some of Martin's class showed their color prefere in handshaking and in laughter. Six colors were placed in nt of each child sitting comfortably on a stool. To the quesn, "What color do you prefer?" the answer might be "None," "I like both colors equally." In this series certain individual ors were compared with the remaining five pairs, testing each or in sequence.

The study of color sense and color perceptibility in children, th detailed and psychologic methods, is more important than the more generalized clinical tests, in so far as the results nd to show more precisely what colors the greater mass of chilen really enjoy and what colors and color combinations should used for their environment that they may be at ease in this lor harmony.

Martin's conclusions were as follows:—among the boys in neral the greatest preference was for the single color blue, but d and violet were also well liked, while yellow and green were s desired, and brown was the least pleasurable color of all. he girls liked red and violet, the colors at the two ends of the ale, better than the blue. In choosing from colors paired tother, it was found that in general both the boys and the girls eferred red; while in both sexes at these youthful ages, brown as never a predominating color. Among those of the older ildren, those of the playground (Spielgarten) period, violet eld the preference, but a certain number of children chose the own. This choice of the varied colors noted was found to be bout the same in the lower grades and among the slightly ounger children as well as among those in the higher classes, the der children. The latter however, seemed more positive in eir choice, owing perhaps to superior understanding. It might e said in passing, that Martin also examined some mentally efective children, who liked blue best, with the brown a close

second choice. No definite conclusions, however, could be drawn in these cases.

Is it possible for us then to choose for a child a certain color from those generally preferred; as for instance, violet, blue, and red, to the colors yellow, green, and brown. In very young children the observer often finds that the nearest color is the one chosen. This, however, is not true of older children. Probably a more decided preference for a certain color is found in the better mentally endowed and in optimistic children. Artistically endowed children, too, are able to make a good selection of individual colors and of color combinations, Martin finds. The recognition of a color is also an important factor, and when this association does take place red is usually the color desired. Finally, after longer experimentation in very young children, red was found to be preferred, with yellow a close second, while gray and brown were rarely chosen. Among all classes of children, young and older, mentally endowed or unendowed, the colors generally chosen were found to be red, yellow, green, blue, brown, and violet, with also the relative tints of rose, lilac, and purple. While the transitional colors, such as the orange tones and the blue-green tints, have a complicated association, they seem to arouse in children quite a different sense of color appreciation from that found in adults. Children, Martin believes, sense in colors the feelings of joy and sadness.

Drawing our final conclusions from the work of this same trained color psychologist, it may be said; first, that a continued preference for any one color does not exist, but that red, blue, and violet seem generally better liked even than yellow, green, and brown. Whether the difference in ages was a factor in choosing a color, Martin could not determine, but the sensing of a color or colors were certainly greater among the more intelligent. Girls, she found, in general preferred red to blue, but boys for some unknown reason preferred blue to red.

The novelty of a color will arouse a certain color sense in children, of either a positive or a negative nature. Association enters largely into the aesthetic value of a color, and the child may show conclusively his pleasure or his dissatisfaction with it.

THE NURSERY

Modern theories in color psychology, particularly the effects of different colors in play rooms and nurseries upon the child and infant, are rapidly assuming an important position. The aesthetic persuasiveness of color schemes as pertaining indirectly

growth repair and to the nutrition of the child's organism is dually becoming better understood. We visualize a modern sery in soft yellow green, the color of sunlight on early spring age, a color both soothing and at the same time mildly stimu- ng. Window curtains of transparent orange material give effect of sunshine, also. Quartz glass panes in the window only give a cheery aspect in themselves but they give ready ess to the emanations of the violet rays. Possibly there may a few violet colored grass rugs upon the floor for their sooth- effect, while the woodwork may be finished in lavender gray. few gay pictures on the wall, of a child playing at games, etc., dull red frames, are useful for their slightly stimulating color luence, all of which tend to make a more or less complete llic picture. While the experiences of the writer in color chology in nursery and in sickrooms has been somewhat pirical in character, yet the moderate success achieved has en a great encouragement to penetrate deeper into the subject.

THE PARALLELISM OF MUSIC AND COLOR

Music and color, says Bleyer, cannot be dissociated in the ild's life, for there is a close analogy between them. The usical scale, he says, is literally a rainbow of sound and of rmony in color, and music may be found to have a common ysical basis with color, as has been already expressed in these ges. For example, the juxtaposition of two colors nearly ke, and of two adjacent notes of the music scale sounded to- ther, produce both a color and a sound discord. The succes- on of colors in the spectrum and of the notes in a scale produce e most harmonious effects which can be imagined, and any sturbance of the order in either case lessens this effect. Dis- rd or harmony may be the result of the combination of certain tes or of certain colors. Note, for instance, the pleasant effect the juxtaposition of red and blue, or of red and green.

Light, like sound, is due to a vibratory motion, and the various lors, like notes of different pitch, have their origin in different tes of vibration. The extreme red of the spectrum, adds leyer, corresponds to the gravest musical notes, while the more ute sounds correspond to the other extreme, violet. The inter- ening colors correspond to the notes between those most grave nd those most acute. However, as is well known, the range of erception for the different rates of vibration is much less for e eye than it is for the ear. For the former it is probably at ost an octave and a half, and for the latter it is nearly eight

times as much. When we begin to understand the whole sound apparatus, the outer, the middle, and the inner ear, and the intricate mechanism of sound associated with them we realize that the ear is a wonderfully comprehensive instrument. As compared with the eye, it is greatly superior in the extent of the sensations it is capable of experiencing. The eye of the child probably possesses barely an octave and a half of light sensation, whereas the average ear has a range of six or seven octaves of sound. More acutely attuned ears have perhaps a compass of even more. Undeniably also, the ear is capable of appreciating minute differences in sound that would be wholly impossible in the case of the eye with light.

It is impossible for the average pediatrist to have at hand all the various types of apparatus for any of the complicated tests with color or music on infants and children. Yet if he but have a little curiosity, and a moderate amount of ability to observe the simple but important details which make up the life of the infant or child, he can derive a great deal of information from the effects of music and color on normal as well as on abnormal children. In the home, music may be a great source of happiness or unhappiness, depending upon the child, the time of day, the type of music, and upon the instrument which renders it. Color also may be a source of pleasure or of displeasure or even of indifference, depending upon the color chosen or upon the color harmony. The radio and the phonograph alike may be instruments of joy or of sorrow, depending upon the artist, the orchestra, or the kind of music broadcast. Thus music may be enjoyable or antagonistic at meals, likewise a color scheme in the room may be pleasurable or unpleasurable. Long before music at meals became a feature in our hotels, Europe had already capitalized its bands and orchestras and music at meals became a fixture. No one can honestly discount, as has been said, the value of a German band or of a barrel organ upon the daily life of the city's youngsters, for the heightened exhilaration resulting from rhythmic dancing has a marked tonic effect on the child's whole organism. Back "in ye olden days," Aristophanes suggested the use of music at every meal, because he believed that its sublime symmetry restrained mental and physical excesses.

Many have but to recall their early days at school when perhaps to drum and fife they marched to fire drill, to recess, or in semi-military formation. With what spirit they marched, with what joy they played! If then the exhilaration of early youth was aroused by such inharmonious and such poorly played music, how much more is the adolescent child inspired by the undu-

ating strains of Victor Herbert's *Gypsy Sweetheart* or by the uneful cadences of the *Mikado*, and by many other melodies of he kind. Certain pediatrists too may have heard children reerring to "mystery" music, to the elusive sounds, which they annot locate, "ghost voices" which come from nowhere in paricular. Memories of the World War bring back stories of the ries of wounded men which comrades were unable to locate, nd in peace time the layman often refers to such sounds as haunting."

As previously explained, notes above a certain pitch cannot be nderstood or their direction ascertained; notes above one thouand cycles, in fact. According to Professor F. H. Firestone and Russell Wightman of the University of Michigan, the explanaion of those haunting sounds is an easy one. These men showed hat to detect the direction from which sound comes, the human ar relies mainly on two factors. One of them is the greater oudness of the sound in the ear nearest to that sound. The ther factor is the time of the sound, which scientists call its phase. The near sound reaches the near ear more quickly than loes the far sound and some ears were found in experiments apable of detecting this brief difference in sound travel. Most hildren are unable to recognize this time difference above a pitch of one thousand cycles, which is far below the average udible high note. Thus can these mysterious sounds which hildren hear be accounted for, at least if such notes are high nd thin, for their ears then have to rely for direction upon the oudness alone. It is interesting, too, as Professor Firestone has pointed out, that for determining the direction of low pitch ounds most persons rely on the time difference, but for high pitch sounds such persons rely on the relative difference in loudness. Sound distance is usually estimated by the child through habit and association, for he may be familiar with this sound and o can guess from its loudness how far away it must be.

A great deal of incredulity may be found in the ranks of pediatrists as to the value of color on nutrition. This may be lue to the fact that these men have not given to the subject the mportance of which it is worthy, or else they may feel that owing to the shorter wave lengths of color as compared with hose of sound their value is by no means so impressive. This is rather an unfortunate attitude. At some time or another every pediatrist, consciously or unconsciously, if he be a close observer, has had enough clinical experience to warrant him in believing in the value of color on the child's disposition, even f he fails to see any such impression on his nutrition. The

writer is reminded of a physician friend who while calling on a patient heard the persistent crying of a two-year-old child in a neighboring room. When the child was playing in that room the crying rarely ceased, but when removed to another place quietness reigned. Investigating, the child was found to be playing on a highly colored crimson floor rug. Upon substituting a green one, the child ceased crying and played happily with his toys. Many a bright orange or crimson covering in a perambulator has been exchanged for a cooler color with marked improvement in bottle feeding and in mood; while the appetite and nutrition of many spoiled and emotionally unbalanced children in particular have been markedly stimulated through the substitution of cooler colored table ware, from the white plates, cups, and saucers, possibly decorated with highly colored and highly imaginative red poppies or other equally excitant color figures, formerly used. In such cases, olive-green dishes, in the experience of the writer, have proven of great service. Toys, flowers, furniture, ornaments, and bric-a-brac in the nursery and playroom, as well as carefully selected colors for the child's clothing, etc., all possessing attractive colorings, and in general all harmonizing with each other, are a welcome addition to any home, to any playroom. And finally paraphrasing the ukase of the Lord High Executioner, in the *Mikado,* "to make the penalty fit the crime," we should always try "to make the color fit the child." [2]

PSYCHIC DISTURBANCES

The child's life indeed abounds in psychic disturbances which contribute to the unbalancing of metabolism. Domestic and social misunderstanding, bickerings, quarrels, economic unrest, hatreds, superior and inferior complexes, shown in extreme egotism or undervaluation of one's self, are only a few. Psychic maladjustments caused by divorce, religious differences, racial, social, or educational discord, too great age disparity in marriage, international marriages, and diverse employment or unemployment situations of the parents are all contributing factors.[60]

One of the modern inventions which, from its psychologic reaction on children, has caused an immense amount of discussion, is the cinema. Does the silver screen exert a wholesome influence on the growing psyche of the child, or are its effects so deleterious that nothing but harm may be gained from it? The answers to these questions and the solutions of the prob-

lems incurred can be given and solved only after patient, scientific work and experience by an unbiased mind.

Scientists who have studied the problem have considered among other things the scope and character of the pictures, the general age and characteristics of the audiences, how much children remember of what they see, whether their sleep is affected by startling screen pictures, how their conduct and behaviorism is influenced, whether their minds are incited to juvenile delinquency, criminality, or sex perversions, whether such moving scenes have a correctional or deterrent influence? Is the motion picture producer inspired by greed or by a real desire to promote interest and wholesome amusement? It is claimed that children may remember for weeks and months events pictured on the screen, and often the length of time only strengthens the vividness of their memories. In an analysis of 1500 cinema pictures, Dr. Edgar Dale found that from 75 to 80 percent of them dealt with love, sex, or crime. The perversion of natural sex passions, an insight into criminal technique, and the cravings for an easy life and for wild parties have been attributed by many scientists to the movie craze. Many producers with a jaundiced sense of propriety and decency display objectionable films rather than those inspiring socially desirable qualities, such as the desire for an education, for travel, or even the healthy emotionalism of religious aspiration. Investigators, studying minor evil effects have found, among other things, an increased restlessness during sleep after a visit to the cinema. At the present time, with an increase of crime among boys and girls of between 16 and 23 years of age, the question arises; Are the films a factor in the child and youth criminality?

According to Roger W. Babson, the basic cause of the crime waves of today is the motion picture theatre, for the impressions which come through the eye are stronger than those which come through the ear. Many children attending crime-breeding motion picture shows, especially at night, may lose all the good effects of what had been taught them in the schools during the day. In fact, were we asked, "Which has the greatest influence in molding the character of children today, the school, the church, the home, or the cinema?" we might well reply—"The motion picture." The motion picture is not perhaps the basic cause of crime, but it may be a potent factor in its instigation.

Professors Herbert Blumer and Phillip M. Hauser of the University of Chicago believe that certain films provide suggestions to crime by stimulating a certain amount of boldness and confidence in the execution of criminal activities, for many pictures

in the past have exemplified a detailed technique in the commitment of crime. In many instances detailed suggestions as shown by the screen have entirely deranged normal behavior and, therefore, metabolism. Investigators have estimated that more than 11,000,000 children, all under 14 years of age, attend a screen performance at least once a week, and that they are often drawn by a vividly advertised and highly sensational picturization of crime and love, truly an unwholesome psychologic diet for children. Children with their sensitive and undeveloped minds, and with a minimum storage of sound sociologic facts as control, in contrast to their parents, probably remember as much as 70 percent of what they see. They retain many questionable and objectionable features which lightly pass over the heads of their elders. Children are also emotionally three times more thrilled by the climaxes of the pictures. They tend to accept as true what is unfolded on the screen and only reject in rare cases events which their own experiences have taught them were untrue.[60]

PICTURES OF NORMAL EMOTIONALISM

The art of poetry has probably never produced a happier picture of natural emotionalism under control and guided by both psychic and physical environmental stimuli, than is portrayed in Whittier's poem:—

The Barefoot Boy

Blessings on thee, little man,
Barefoot boy, with cheek of tan!
With thy turned up pantaloons,
And thy merry whistled tunes;
With thy red lip, redder still
Kissed by strawberries on the hill;
With the sunshine on thy face,
Through thy torn brim's jaunty grace:
From my heart I give thee joy!
I was once a barefoot boy.
Outward sunshine, inward joy:
Sleep that wakes in laughing day;
Health that mocks the doctor's rules;
Knowledge never learned of schools,
For, eschewing books and tasks,
Nature answers all he asks:
Hand to hand with her he walks,
Face to face with her he talks,
Part and parcel of her joy,—
O, for festal dainties spread,
Like my bowl of milk and bread,—
Cheerily, then, my little man,
Live and laugh, as boyhood can!

What has been said by Whittier in verse is beautifully expressed by Anatole France in prose. There is, however, in these lines a rather more intensive leaning toward the psyche, as befitting the development of young women of those other days of paramount feminine qualities. Sylvestre Bonnard is speaking to Maitre Mouche:—

"It is only by amusing oneself that one can learn—The whole art of teaching is only the art of awakening the natural curiosity of young minds for the purpose of satisfying it afterwards; and curiosity itself can be vivid and wholesome only in proportion as the mind is contented and happy. Those acquirements, crammed by force into the minds of children, simply clog and stifle intelligence. In order that knowledge be properly digested, it must have been swallowed with a good appetite. If that child were intrusted to my care, I should make of her not a learned woman—for I would look to her future happiness only—but a child full of bright intelligence and full of life, in whom everything beautiful, as art or nature, would waken some feeble responsive thrill. It would teach her to live in sympathy with all that is beautiful; comely landscapes, the ideal scenes of poetry and history, the emotional charm of noble music. I would make loveable to her everything I would wish her to love—even her needlework. I would make it pleasurable to her by a proper choice of the fabrics, the style of embroideries, the designs of lace. I would give her a beautiful dog and a pony to teach her how to manage animals. I would give her birds to take care of so that she could learn the value of even a drop of water and a crumb of bread. I would have her find delight in exercising cheerily. I should teach her that Christian wisdom which elevates a love all suffering and gives a beauty even to grief itself. That is my idea of the right way to educate a young girl." [61]

With the advent of naked materialism and of progress along the line of mechanical inventions, the trend of men's minds seems to be away from normal and healthy emotionalism toward a perversion of natural physical and psychic environmental stimuli.

The child's mind is very complex, perhaps more so than is that of an adult, for the thoughts of the latter are subject to control through reason. It is fluid, the child's thoughts are wavering, and only the elements of healthy environment guide them into wholesome channels. To many, this fluctuating state of mind is disappointing, for changes and adjustments are continually taking place. If the child's reasoning is immature and therefore unsound, it can be easily realized that psychologic stimuli of an unfortunate character may lead its thoughts into wayward paths.

Social and other changes are here at the present time and children will inevitably change with them. Newer psychologic problems are at hand and must be met with understanding, but the best of the old order must be retained. Mental disturbances arising from the cinema and from other modern inventions may activate crime and perversity. The child of today is too dependent upon the finished article made especially for his enjoyment.

Many modern children lack incentive, an intelligent natural enthusiasm, and the satisfaction in trying to do things for themselves. They have automobiles rather than a make-shift bicycle, the finished ski runners rather than those made from barrel staves. Initiative cannot be taught; it must be gained in the order of an experiment. Personal initiative is a security against the bewilderment caused by these rapid and sudden changes.[60]

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CHAPTER 15

NATURE'S APPETIZERS

UNQUESTIONABLY an adequate metabolism cannot be completely realized, even with the most carefully chosen foods and with exceptional environmental factors, without the aid of biophysiologic agents. Biophysiologic appetizers are natural condiments, for, in a broad sense, they create and stimulate a desire for foods, fluids, and rest. Table condiments, on the other hand, fulfil no plausible mission in the child's dietary and should not be used. The natural appetizers are hunger, thirst, and fatigue.

In times of stress, during periods of crop famine, droughts, and war, the word "hunger" reechoes far less resonantly than during peace, plenty, and contentment. For in times of peace, the word carries with it another meaning, denoting a much-to-be-desired state of body function. Indeed, if hunger were not experienced, there could be no adequate growth nor development, no happiness, no contentment, no physical or mental progress.

Cannon has established that the subjective sensation of hunger is caused by a certain type of contraction of the fundal end of the empty stomach stimulating the sensory nerves in its wall. The observations of Ginsburg, Tumpowsky, and Carlson tend to show that the infant's stomach provides feeble tonus contractions at the fundal end, even one hour after nursing. As the stomach discharges its contents, these tonus undulations gradually increase in frequency and intensity, until by the end of from two and one half to three hours they become transformed into vigorous hunger contractions. The interval between feeding and the onset of these contractions varies for each infant, apparently depending on illness or health, on temperature (climatic) changes, on nutrition, on age, on organic growth and developmental impulse, and on many other environmental factors. The minimum period is usually about two hours, the maximum three to four hours after the meal in older infants. Yet within the first two months of life, in many cases, the feedings may be given to advantage even within this minimum time limit.

In the normal infant and child the presence of strong hunger contractions is undoubtedly a biologic evidence that the stomach is ready to receive food. These stomach contractions tend to recur at intervals, as long as the stomach is empty. In the un-

healthy, sickly infant suffering from malnutrition, from exhaustive nutritional diseases, as well as from bacterial onslaughts, these periods seem to occur at longer intervals. In young infants and children suffering from these complaints and refusing any, or but small quantities of food, it is illogical and unbiologic to feed them within minimum periods; the feeding times should be extended often even beyond the maximum limit, perhaps to five and even to six or seven hours. It is often forgotten that the proportion of food that can be digested by the child is what really counts, and not the amount of food he can be forced to eat. In many cases of children suffering from an inherited marked hypo- or hyper-stomach dysfunction, but apparently otherwise normal, these contractions seem to occur at longer intervals, apparently without discomfort. The start of these hunger contractions is controlled by the intrinsic nerves and is quite independent of the extrinsic counterparts, which exert only regulatory effects. That the child's body as a whole must be in as perfect balance as possible in order to function normally is shown in the activities of the stomach, in that although it is a self-starting organ, yet it has an intimate relation to all the vital organs, glands, tissues, etc., through the autonomic nervous system, which maintains the general tone of the organic background of the child's emotional and, perhaps, intellectual life.

That these physiologic functions of the digestive system, particularly those of the stomach, exert an enormous influence upon other parts of the body, was thoroughly investigated by Wada, who found that the respiration, vasomotor flow, and the salivary secretions were all profoundly influenced by the hunger-contraction rhythm. Indeed, an especially close relationship was found in the case of the salivary flow, which is one of the most immediate accessory phenomena of the hunger contractions. Of interest, too, is the fact that the sensation of hunger in infancy and childhood occurs synchronously with the hunger contractions of the stomach, showing unreservedly that the stimulus from the gastric organ affects the cortical integration centers in some way so as to set up impulses toward the coordinated action of securing food.

The wonderful phenomena of the stomach contractions not only arouse the sensation of hunger, but also prepare the whole body for activity, even during the child's unconscious states. Clinical observations, however on an unscientific scale, seem to show that the active youthful energy of the body movements in health tend to occur simultaneously with the hunger contractions, while in the quiescent periods of the child's life very few

such bodily movements occur, as is seen particularly in sleep. Moreover, the child cannot control the hunger rhythm directly through the power of its will or motive.

THE SYMPATHETIC NERVOUS SYSTEM

The sympathetic nervous system is not a nerve trunk in itself, for its whole system is but an outflow from the cerebrospinal system which connects the brain so intimately with the other parts of the organism. This great connecting body is made up of efferent fibers given off by the thoracic and the upper lumbar segments of the cord, and consists of a chain of ganglia which are united by nerves with a particular region of the spinal cord. Certain fibers of the sympathetic system, the so-called white rami, are what may be spoken of as association fibers, connecting as involuntary efferent nerve tracts one part of the central nervous system with the other. The sympathetic supplies all the vasoconstrictor nerves of the body as well as the accelerators to the heart, inhibitory nerves to the intestine, and secretory nerves to the epidermal glands. Moreover, it supplies communicating fibers to the glands of the stomach, to the pancreas, and to the salivary glands, also to the bloodvessels, heart, bronchi, liver, kidneys, small intestine, colon, and to the bladder, all of which can be acted upon reflexly. It can be readily seen that the nervous system brings any part of the organism into relationship with any other part and the same afferent nerve fibre connected with one organ can at times, unlike the speaker over the telephone who can address but one hearer, be hooked up with several efferent fibers to other organs. In the actual functioning of the nervous system, the afferent or incoming impulse streams, whether simple or complex, are translated into efferent or outgoing impulse streams so organized as to evoke serviceable responses, whether simple or complex, reflexes, in fact; and it is with these reflexes that we have to deal. Strong stimulation, more powerful environmental stimuli, arouse a more vivid impression than do weak, and evoke a sharper, more emphatic reflex, for they bring into action simultaneously a series of parallel reflex paths. Finally it should not be forgotten that the activity of the sympathetic nervous system is regulated largely by centers located chiefly in the medulla oblongata, which are largely of reflex character. The sympathetic nervous system influences digestion largely through its gland control. To be more explicit, the parotid gland receives parasympathetic fibers from the inferior salivary nucleus along the glosso-pharyngeal nerve; while

the submaxillary and sublingual glands receive parasympathetic fibers from the superior salivary nucleus through the pars intermedia and the chorda tympani. Such sympathetic fibers are trophic nerves, which produce a specific change in the gland leading to the formation of the ferments contained in the secretion. On the other hand, the parasympathetic fibers are secretomotor, causing the secretion of salts and water and the dilation of the arterioles. Fibers of the vagus nerve pass to the stomach, and if the vagus be excited at its brain center, it establishes an immediate flow of gastric juice. Thus gland after gland, as well as all organs and tissues of the child's body, are each and every one influenced in the production and distribution of their secretions, enzymes, and ferments; thus the cells and tissues in the various metabolic activities, through the action of the central nervous system, are all similarly affected.[1]

PSYCHOLOGIC INFLUENCES

As a magnet, the stomach's hunger mechanism attracts to itself all the great psychologic influences which enter into the normal functioning of the digestive system. The central nervous system with its attendant, the sympathetic, which regulates the tonus and the rhythm of the hunger contractions, are very sensitive to emotional stimuli. Among other functions, the sympathetic supplies communicating fibers to the glands, to the small intestine, and to the colon. These organs in turn enter into a general relationship with all the other organs, glands, and tissues of the child's body, through the activities of this sensitive nervous body, the sympathetic, an outflow from the cerebrospinal system. Strong or weak environmental stimuli from without or from within the child's body arouse, by way of the reflex centers, correspondingly strong or weak impressions, more or less emphatic reflexes.[2]

THE REFLEX CENTERS

On other pages we have incidentally referred to the reflex centers as cerebral nerve centers. As these centers are of such great importance in the so-called reflex arc, it is well to give them fuller consideration. These nerve centers in the medulla oblongata which receive physical stimuli may be called, according to Bayless, analysers. They may be in part also rheostats and transformers. Each center may be also a biochemical laboratory, which through its cells changes the form of biologic im-

pression induced through the stimuli of sound and light, chemically, to produce a different substance which affects, in some not understood way, the character of the impulses along the central nervous system. Of this, however, we know nothing; yet we can interpret symptomatically the nature of the responses along the nervous system. As the central nerve system, through itself, through the sympathetic, and through other subsidiaries, coordinates, in fact, stabilizes all the important organs of the child's body, among which are the organs of nutrition, we can logically assume that the latter organs will be either stimulated or impeded in their growth and function by the character of the stimuli cast upon the reflex centers in the brain. Direct evidence of the psychic value of sound and light, in other words music and color, for instance, can be seen clinically in the stimulated appetite of the child. There being so many physical environmental factors concerned in well balanced metabolism, we can often only reason out the psychic reactions indirectly. Viewing the sympathetic as a coordinator, we can safely assume that there is an interlacing of all nerve centers so that the stimuli from any one may be exchanged with those of other centers. For instance, although the sight, smell, and taste, particularly the latter, affect the desire for food, it may be possible that the nerve center of sound may have a somewhat similar action on digestion, as do the nerve centers of the other three mentioned senses.[1]

PAVLOV

The sympathetic nervous system, among the other links of its extensive chain, coordinates with all the nerve centers. No thesis on psychic reflexes could be aptly concluded without a reference to the achievement of that great Russian physiologist and pathologist, Pavlov, whose brilliant and original experimentation on dogs verifies the point in question. In this work on the psychophysiologic function of nutrition he solved many problems of digestion. Among his many contributions to these problems he discovered that the vagus contains specific secretory fibers for the gastric glands and that the gastric juice works with great precision, possessing, as it flows from the glands, a constant acidity. He found, also, that its rate, flow, and composition varied with the kind of food eaten. Identical conditions were claimed for the pancreas. Pavlov, too, regarded the higher nerve centers from the point of view of the psychologist, and by physiology and psychology traced the relationship between external

phenomena and the reactions of organisms to them without introducing the complications of consciousness. He explained the method in a lecture on Conditioned Reflexes given at the International Congress of Physiologists at Groningen in 1913. His experiments were simple in character. When food was presented to a dog with a salivary fistula, a reflex secretion was produced. If a bell of a certain tone was rung a number of times, simultaneously with the presentation of this food, it was found that the sound of the bell alone was sufficient to excite the secretion, although originally it had no effect whatsoever. Again, in another experiment he found that when a flash of light, for instance, was followed regularly by the presentation of food at an interval of 10 seconds, afterward the flash of light alone was succeeded by the secretion of saliva, but not, however, until ten seconds had elapsed after the time of the flash of light. This interval is filled by the internal inhibition of the secretory centers.[1]

APPETITE JUICE

The psychic juice stands in relation to the hunger mechanism much as did Ruth to Naomi; "Whither thou goest, I will go." This gastric secretion, obtained through the sensory stimuli of sight, taste, and smell, as well as probably from sound and light, is usually referred to as psychic, or better, appetite juice. Of sensory stimuli, probably taste is the most effective, for the vagus supplies the taste buds in the pharynx through a small component of the special splanchnic sensory element. Appetite juice is the result of a series of gastric contractions occurring at fixed intervals.[1] This secretion must not be confounded with the hunger contractions, however; for they are widely different as to physiologic basis, as to localization, as well as to their psychic elements. Indeed, hunger may be satisfied when the appetite still calls.[2] Consider, for example, a tempting dish of ice cream or an attractive piece of cake, when the child's hunger is wholly satisfied and he no longer needs food. Through the sight and smell of the food the initial flow of psychic juice is brought about, and the continuance of the flow of this juice during digestion is provided for by the action of its acid or of its digestive products on the mucous membrane of the pyloric end of the stomach, and the secretion of the pancreatic juice and that of the bile is called forth by the action of these same products on the mucous membranes of the duodenum.

The proper starting of the digestive process is conditioned

by the satisfaction of the palate and the consequent flow of the first digestive fluids. All clinical observations on children would seem to warrant the statement that the normal flow of the first digestive fluids, the saliva and the gastric juice, is favored by the pleasurable sensations which accompany the taste and the smell of food during mastication, as Cannon suggests; and it is our contention that the psychic value of certain physical stimuli, such as sound and color, favor pleasurable feelings, and that the degree of daintiness with which food is served and the little attentions to aesthetic details are but additional environmental factors in nutrition.[1]

As the hunger urge is so closely bound up with hunger satisfaction, hunger may well be referred to as an appetizer. Thus, the initiation of the hunger contractions from reflex sensory stimuli and through the central nervous system is undoubtedly impossible, as they occur at biologically fixed intervals. Yet they can be inhibited by emotional responses through the stimulation of the central nervous system. Muscular activity of infants and children may increase the gastric hunger activity by increasing the vagus tonus, as well as the chemical changes in the blood stream.

The same effect applies to the stimulation of the nerve endings of the skin through cool or cold water applications. Hence the necessary early morning bath. In our temperate zone it is generally recognized that exercise, cold weather, and cold baths increase the appetite and hunger sensations. The term, "cold," however, should be used with reservations. Exercise and cold baths are relative terms and cannot be indiscriminately applied to all children. While the temperature of the morning bath is usually lower for adults than for children, lower for children than for infants, what is cold to one child is not cold to another, depending upon the reactionary responses which are relative to race, sex, age, heredity, and environment. Unfortunately, however, this increase in hunger and appetite following exercise and bathing may be only apparent, and may reflect a condition of increased excitability of parts of the central nervous system, so that the apparent impulses which give rise to the sensation of hunger and of appetite produce a greater central effect. There can be no doubt that the modern custom of bathing sickly children before each meal is an adjunct to the science of healing. But, if such bathing is done too soon after a meal and during digestion, there may result cramps, contractions, and indigestion from circulatory disturbances or from chemical changes in the

blood stream. Many drownings and other deaths may be laid to these physiologic and metabolic disturbances.

THE EMOTIONS

The child's psychologic environment has much to do with his emotions, and his emotions have much to do with his health and happiness. The conditions favorable to proper digestion, to a normal amount of appetite juice, to physiologic secretions of the intestines, of the liver, and of the pancreas, are wholly lacking when this psychologic environment is disagreeable. Vexation, worry, jealousy, anger, fear, joy, happiness, contentment, hope, physical and mental progress all react through the central nervous system and its associated agencies to unbalance or to balance the co-relationship of the immature organs of the digestive system, and, in consequence, of other organic systems and mechanisms.[2]

Through the sympathetic nervous system, too, the movements of almost the entire alimentary canal are affected pleasantly or adversely by pleasurable or unpleasurable emotions. Thus, too, do these emotions make possible favorable or unfavorable metabolism. Clinicians have often observed the reflex action of great emotions on the gastric movements of the stomach and intestines, as well as upon their secretions. Vomiting and diarrhoea have often succeeded emotional outbursts. The writer can recall a projective type of vomiting and a watery mucous diarrhoea in a young seven-year-old girl, following a severe fright caused by a young playmate donning a hideous mask and an Indian blanket and coming upon the child stealthily in the shadows of the evening.[1] Fault finding, undeserved or brutal punishments react through the central nervous system and its associated agencies to unbalance the sensitive and immature organs of the digestive system.

Brutal physical punishments, such as flogging, hitting the child over the mastoid region, over the face, dragging him by the arms or legs over the ground, may not only induce pain, but may evoke changes of the deep-lying structures of the body, as well as causing emotional instability. As the sympathetic nervous system coordinates all the organs of the child's body, we are assured that stomach and intestinal pains arouse changes in other organs, in the adrenal gland; in fact, in all the endocrin and gonad systems. In truth the child's body make-up may be subjected directly or indirectly to the unbalancing of the normal

functions. It is not merely imagination, we believe, to assume that jazz, discord in sound or in color may arouse psychic pains under somewhat similar conditions.[1] Physiologically, abnormal emotional states tend to inhibit the salivary flow, the secretions of the stomach and of the intestines, of the bile, and of the pancreatic enzymes. The proper selection and preparation of the child's food may well be almost perfect, but the splitting of the food within the digestive tract cannot take place adequately unless the peristaltic movements of the stomach and intestines help to change the foods into end products and carry away the waste. Such natural activities of the stomach and intestines are often completely inhibited by unhappy emotional stimuli. Even the kneading movements of the small intestine and the reversed peristalsis of the large intestine cease under such emotional strain. Under emotional excitement the little patient at times experiences a pain in the pit of the stomach; there may occur also a stagnation of the food contents along the digestive tract. Such occurrences come often under the eyes of the pediatrician. Some time ago the writer had under observation a child whose nutritional life, as far as proper food and its preparation were concerned, could not have been improved upon, yet through the fault finding and nagging of his parents he developed a subacute form of gastrointestinal intoxication with all its attendant evils of headaches, constipation, infrequent pains in the limbs, malaise, and mental depression.[1]

There exists, too, a close relationship between emotion and muscular action in children, and happy or unhappy states may cause a less or greater muscular action. This decreased or increased muscular action favors a corresponding decreased or increased gastric food urge. Indeed, it may be safely said that a child capable of strong emotional reactions is one of strong muscular energy and is therefore in good physical condition. Every vigorous movement of the child's body involves the viscera, the heart, and the lungs. The constrictions of the blood vessels and the acceleration of the heart beat which attend emotional excitement in the child result in an increased arterial pressure. The higher the blood pressure, the faster the flow of blood through the relaxed and noncontracted arterial vessels. Thus, the number of red corpuscles carrying oxygen from the lungs to the heart, to the brain, and to the muscles in action will be increased, and the conveyance of oxygen will be speeded up accordingly. This extra demand made by the muscles of the child's body involves an increased action of the nutrient organs, an urgent demand for food by the digestive system, by the biologic

cell, as shown in an increased metabolic rate and points a reflected picture of an organic need for a well ordered dietary.

Such visceral changes are important; for through them a series of processes takes place in the alimentary canal: the shifting of blood from the abdominal organs to organs immediately essential to muscular exertion, the increased vigorous contraction of the heart, the discharge of extra blood corpuscles from the spleen, and the quick abolition of muscular fatigue effects the mobilizing of sugar in the circulation. Emotional excitement under control increases the respiratory rate, resulting in the better ventilation of the lungs. Under such forced respiration the carbon dioxide content of the blood can be much reduced. The heart beats less rapidly after deep breathing, and after subsequent exercise returns more quickly to normal. This emotional excitement may be so marked at play that active, well conditioned children often go past their habitual meal periods, and either inhibit or forget their stomach food urge through the pleasures of the moment. In fact, in one instance, the writer observed a group of children playing soccer in an open field. They became so interested, were so thoroughly absorbed in the game, that the meal time passed without apparent annoyance. Without the requirements of hunger, the nursing mother cannot adequately give her infant a properly metabolized milk-food, for she may through the perversities of an irregular appetite juice eat too often and of foods in excess which are unsuitable for proper nourishment of the infant.

The profuseness and activity of this secretion evoke in the child the urge for food, normally for simple food; and instead of the painful contractions of an empty stomach with fitful appetite sensations, feelings of buoyancy and lightness follow a well ordered meal. Pavlov has spoken extensively of the psychic gastric juice and Carlson considers that it stimulates the sensory nerve endings in the gastric mucosa of the child and directs the flow of consciousness toward the matter of taking food. It is extremely interesting to view peculiarities in the ebb and flow of this secretion as evidenced in the behavior of the infant, for these characteristics are often seen as a marked gastric dysfunction fundamentally arising from heredity and gaining great impetus from environment.

Bauer and Deutsch found no gastric juice in a baby's stomach after it had reached eagerly for its bottle. Pfanndler noted that in babies who nursed actively the stomach emptied itself sooner, and that the degree of acidity of the juice obtained was higher than in infants who were fed passively or through a tube. A. H.

Meyer found a great variation in gastric acidities in the same child, and believed that these variations might depend on the presence or absence of Pavlov's appetite juice. Schmidt found that the active suckling stimulates the gastric secretion to renewed activity, the hunger urge naturally increases this activity. Even the discountenanced rubber pacifier is advocated by Meisl to arouse the flow of this stomach secretion. It is to be hoped, however, that no one has advocated gum-chewing. Bogen, experimenting upon a three-and-a-half-year-old boy with a stenosed esophagus and gastric fistula, concluded that the secretion of psychic juice was not imaginary but that it did occur. Leo, in 1888, found free hydrochloric acid in the stomachs of newborn, unfed babies, and remarked that in older infants the stomach was rarely entirely empty, and that a few drops of a thick, yellowish, acid fluid remained. Wohlmann reported that the secretions of the infant's stomach, when empty, contained a viscid, colorless, glassy mixture, without any free hydrochloric acid, but this experimenter took his findings from one to two hours after feeding. Hess has shown that the stomach of the newborn unfed babe secretes a highly acid juice.

In normal children, undoubtedly, the gastric glands are never idle, and there is probably a continuous secretion of gastric juice in their normally empty stomachs. It was Carlson, we believe, who coined the phrase, "hunger juice." The empty stomach of the normal infant probably secretes a juice at times which is as acid as that of an adult, but Taylor believes that there is no psychic juice secreted therein. It is very difficult, if not impossible, for the clinician to differentiate between hunger and "psychic juice," if indeed any comparison can be made. However, if such a comparison is possible, it can better be made as regards the contents of the infant's stomach, rather than that of the older child, since in the former the psychic reflex centers are undeveloped and the brain immature. The infant's hunger juice even contains pepsin. Some of the acid stomach contents of the infant find their way into the duodenum, for Sedgewick has discovered that its contents are acid in character. It seems entirely probable, too, that the secretion of the alkaline pancreatic and intestinal juices, which in the adult regurgitate into the stomach and tend to lower the acidity of the stomach juice, are very deficient in the infant. It might be of particular interest to mention Engel, who has stated his belief that gastric hyperacidity or hypersecretion of the gastric juice is undoubtedly an etiologic factor in the causation of pyloric stenosis. It has

often been observed that the stomach of the starving infant can secrete from 50 to 200 cc. or more of highly acid juice daily.

The many disproportionate findings of various groups of experimenters in regard to the amount and kind of gastric secretion in the infant's stomach seem to warrant the conclusion that these men have run afoul of minor dysfunctions transmitted from heredity. It has been observed that during the digestion of milk the gastric contents of the infant are of low acid value, due in part perhaps to the gastric secretion's binding power for acid, as Aron believes, or in part to the relatively slight stimulation which it exerts upon the gastric glands. In this ingestion of milk by the infant, Allaria has pointed out the great chemical and mechanical advantages of having it well mixed with saliva, which normally is thick and viscid; in which case the infant secretes an amount probably equal to from ten to twenty percent of the ingested food. It would not be forgotten that in hunger the infant's stomach secretes continuously and with intermittent intensity a highly acid juice, a part of which, at least, flowing into the small intestine, acts as a disinfecting or detoxicating agent. In fact, in alimentary disorders, such as summer diarrhoeas, and in somatic nutritional irregularities, advantage has been taken of this knowledge to extend the feeding periods and to give easily digestible, metabolizable foodstuffs, all of which establish a heightened tonus of the alimentary tract and an increase of the gastric hydrochloric acid.

There is a difference of opinion regarding the time of the hunger urge in infants, but in normal children the stomach contractions tend to follow, in general, a biologic fixed course. It is this misinterpretation of nature which has led inexperienced men into giving food before requirement demands, or advising prolongation of the feeding period until the gastric contractions have become exquisitely painful. Hunger contractions, without the satisfaction of an adequate food supply, will cause wakefulness. On the other hand, improper feeding or overfeeding at or near bedtime will arouse dreams. Clinical experience has taught that the child's hunger sensations are not those of any one local organ, but involve the whole organism, for they stimulate the motor and sensory apparatus. The organism, therefore, is brought into a state of readiness to receive food. Indeed, one might well say that the whole organism is placed in a state of tension to prepare itself for the strife and struggle of the child to obtain this food.

With sick infants and children, long intervals may elapse be-

fore the patient responds to a need for food, and it is unwise and unbiologic to feed them before this urge arises. In a normal, very healthy child, the stomach mechanism may sometimes function with a minimum of psychic control. This is of rare occurrence, however. On the other hand, this mechanical process may be tied up with the most complex cortical processes, entering into the fabric of the higher sentiments and affections, and thus become an important factor in shaping the child's behavior and conduct. Sauciness, sullenness, bad temper, and a lack of the social graces, as well as organic disturbances, may be due to satiety, rather than to insufficient food; for in order to keep the child well, happy, and affectionate, he must be kept hungry. Hunger not only determines the inner workings of the child's body, but acts also as a driving force for his muscular apparatus, the arms and legs, etc. Even sociologic complications which are the least understood of the child's life may be traced back to simple events, or to a faulty and abnormal craving for food, and therefore to an ordered or a disordered metabolism.

In a limited sense, hunger in the young can be controlled, for opportunities and methods may be found for training children in food habits. Particularly is this true in the case of older children, whose minds may be trained to follow a certain periodicity in taking food, which is important in early school age. The problems of their school work and of their outdoor play can be minimized if their natural tendencies are conscientiously understood. Without an adequate food supply, without a proper selection and preparation of this food, without the normal cravings for food, without a proper balance of food principles in metabolism, and with the suppression of many natural desires for certain foods, the child's life is often one of mutiny and often he develops unfortunate characteristics. The degree to which the dynamic forces of the child's life may be controlled depends upon the extent of one's knowledge of those forces and of means for their control. It may be said that while many cases of food sensitization have their origin in damaged heredity, others arise from a faulty physical and psychologic environment. Many simple food idiosyncrasies in children, not of transmitted origin, can be eradicated through the bettering of environmental factors and through the lengthening of the intervals for food ingestion.[2]

BLOOD SUGAR

Physiologic reactions and psychic stimuli to emotionalism may be seen on every side. Probably a marked descriptive one is that

of a more or less permanent glycosuria which the pediatrician often meets in clinical practice among emotional children, particularly around the pubertal age in early maturing girls. Medical literature is full of such cases. In the well fed child the liver contains an abundance of glycogen which is called upon in times of need. At such times this glycogen is changed and set free in the blood as sugar. Under ordinary circumstances there is a small percentage of sugar in the child's blood, probably from 0.06 to 0.1 percent. When a small amount of this sugar is present the kidneys are capable of preventing its escape in any noteworthy amount. If the percentage rises high, say to 0.18 percent, however, the sugar passes over the obstacle set up by the kidneys and is easily shown through urine tests. This condition of "glycosuria," then, in young girls, may in certain conditions be evidence of an increased sugar content of the blood. Through the emotional states of the child and through the stimulation of the sympathetic by adrenalin, the sugar in the liver can be liberated to such an extent that glycosuria may result.

Around puberty, and at puberty, is a period of so much emotional excitement, in young girls particularly, that severe emotional disturbances can produce unforeseen reactions on the body and on metabolism through a perverse stimulation of the thyroid gland; hyperthyroidism, in fact. At such times, under such circumstances, pediatricians observe menstrual disorders in young girls; in young boys frequent micturition; in young girls, too, there is often found a precocious secretion of breast milk, etc. It is therefore around this period and to offset just such conditions of unbalanced emotionalism and of their often unappreciated results, that the esthetic values of music and color may be so beneficial.[1]

REACTIONS

The role which fundamental, natural, emotional responses play in the organism of the child may be seen in many surface manifestations of excitement. The contraction of blood vessels, with the resulting pallor, the pouring out of "cold sweat," the inhibition of the saliva flow, the dilatation of the pupils, the rising of the hairs, and many other bodily changes are recognized as accompaniments of pain and of great emotional disturbances, such as horror, anger, fear, rage, or deep disgust. These disturbances are the routine experiences of many a child's life. Other organs, however, hidden deep in the body, also respond to emotional stimuli; particularly are those organs affected

to an important degree which are concerned with the physiologic functions of the body; namely, the stomach and intestines. In the adequate functioning of these organs, the nutritional blood stream is able to supply the various types of cells of all the other organs, which in their co-relationship tend to balance up the body as a whole. Food given at irrational times is abnormally digested and metabolized, and acts more like a poison than as a food. Many incipient hereditary dysfunctions and also those of purely somatic origin, often manifest themselves as a result of these irregularities. The stronger the hunger urge, the quicker the psychic response to the sight or smell of food, which under normal conditions should start an outpouring of the appetite juice. The importance of the emotional psychic secretions of gastric juice is seen in its ready flow during digestion, which is aided by the action of the acid contained within, which in turn aids in the action of its digestive products upon the mucous membrane of the pyloric end of the stomach. The secretions of the pancreas, the bile, and the mucous membrane of the duodenum are likewise stimulated by the action of this acid. Hornborg found that when a little boy chewed agreeable food a more or less active secretion of gastric juice followed, whereas the chewing of an indifferent substance such as gutta-percha resulted in no such secretion. These facts are of prime importance, for foods should be daintily served to children, particularly when they are ill, and when the appetite is fickle.

THE HUNGER URGE

Symptomatically, the hunger urge in children is a more or less uncomfortable feeling of tension, pressure, and pain referred to the region of the stomach. In normal children, or in infants, the hunger pains must be exceptionally strong to be painful. Usually, if we accept the child's statements, the sensation is one of uncomfortable tension, accompanied by a feeling of emptiness in the region of the epigastrium. In infancy, when primitive animal instincts prevail, with a specific quantity and quality of food, hunger pains can almost be timed by the clock. At the time of hunger urge, when the gastric contractions begin to be felt, accessory phenomena often make their appearance. There may be a feeling of general lassitude or weakness, perhaps of nausea, nervous irritability, vasomotor instability, and even fainting spells. In some children, the sensation of hunger produces a state of hyper-excitability of more or less intensity, while in others no such developments occur. Clinical experience makes

one feel that the intensity or persistence of this hunger urge runs parallel with the degree of body activity and with the rate of metabolism, for it seems to be more marked in the very young and active and in those inheriting a rapid growth impulse.

HUNGER IN THE NEWBORN

In the newborn and in the early period of infancy, when the higher centers of the brain are undeveloped, and, in consequence, the association of ideas is unborn, with but an instinct less than that inherited by the lower animals, the infant places within its mouth everything within reach, to be rejected if unpalatable, or retained if appetizing. This is also a primitive instinct, which probably connects the gastric urge with the process of feeding. Conscious direction and imitation may play a large part in teaching young birds and animals to feed, but one cannot associate such primitive habits with the newborn. The hunger mechanism is bound up with the inheritance of the stomach. However, as function is not transmitted as such, but is irretrievably associated with an organ, it is conceivable that the inheritance of an imperfect organ would produce an irrational functioning of that organ. It is also not hard to believe that this functional irregularity might strongly interfere with the accepted timing periods of these gastric contractions and of the hunger urge, for no two infants are alike in the functioning powers of their organism.

As the hunger mechanism itself is so variable, so are the different degrees of the hunger urge. Even in infants and children, when gastric dysfunction may be of no apparent consequence, the time required for emptying the stomach, and hence that for the hunger contractions, may be very uncertain. It does, however, determine to a certain extent the feeding habits. Young animals, children, and infants tend to take food as soon as the stomach is partly empty, and before the hunger urge becomes manifest, unless restrained. If food is at hand, and if the infant is very young, and if the hunger periods are of greater frequency than in an older child, there may be a continuous desire to eat. The empty stomach at birth, even in the prematurely born, exhibits the typical periods of tonus and of hunger contractions, as in the adult; the only difference being their greater frequency, such as one would expect in an immature but slowly rising growth impulse rate. Therefore the periods of feeding must coincide as nearly as possible with the onset of the hunger pangs, so different in different infants, even at the same age. The quantity

and quality of the food, its biologic principles and ingredients must progress hand in hand with the infant's age, growth, and the degree of its organic function.

Experience leads one to believe that these stomach contractions appear soon after birth in an empty stomach, an organ trying to adjust itself to an alien world. The young physician is often hoodwinked by the onset of these contractions, and may attribute the signs of restlessness to a disordered digestion, for a sleeping infant beginning to feel pain may wake up and cry, and the more vigorous the contractions, the more violent the crying. The interpretation of these cries is often difficult. The older child can usually express himself in words, the infant cannot do so. Even a study of the tone of the cry may lead nowhere, for the crying of one infant may be quite different from that of another. This difference possibly depends on the age of the child, his constitution, temperament, or upon disease or health, upon the severity or the mildness of the gastric contractions, upon seasonal changes, upon emotional reactions, and on many other factors; for the peculiar rhythm and tone of the hunger note is purely individualistic. A young and growing child experiences a greater hunger than that of either of his parents, for in addition to the formation of new tissues and new organs, the child is more active than the adult, and his body surface is larger in proportion to body weight, hence he loses proportionately more weight. All this calls for greater quantities of food.

Several conditions probably operate to produce this greater hunger urge in the child. First, there may be a greater rate of gastric secretion, so that digestion in the stomach requires less time. Second, there may be a hypermotility of the filled as well as of the empty stomach, because of the actual immaturity of the stomach tissues. Third, there may be greater sensitiveness to afferent impulses destined for that part of the brain concerned with the hunger sensation. Along with the stomach contractions of infants and children in hunger there are undoubtedly active contractions also of the small intestine, stimulating fecal movement. Sometimes in older children rumbling sounds may be heard in the abdomen and can be traced to the stomach, even though it is apparently quiet. Such sounds are probably due to local stimulation resulting from the distention of gases, hence mostly confined to the large intestine. In our experience, these sounds are frequently heard in digestive upsets, in gastrointestinal intoxications, where the infant food modification or the child's diet is faulty.

Sometimes in the case of an infant in sound, vigorous health,

with thin abdominal walls, we imagine that these stomach contractions can be felt with the finger tips on the site of the fundus. Has it been the experience of others that the knee jerks, varying in strength, time, and occasion, run parallel with the appearance of the gastric contractions? Scientific records tend to show the marked increase in the reflex excitability of the spinal cord simultaneously with the strong hunger contractions of the empty stomach. This reflex excitability usually falls to normal level during the pauses between the single contractions, and after the strong hunger period it appears to be somewhat lower than normal, lower after a meal or during digestion than before a meal. Evidence seems conclusive that hunger leads to or is associated with an increased excitability of the cerebrospinal axis. This condition may possibly account for irritability, restlessness, and the inability to maintain a fixed attention, and is often associated with strong hunger pains in some children and with moderate pangs in others. As the stimulation of the gastric mucosa produces an increase in reflex responses, too hot or too cold substances given the child to drink may also increase the knee jerks. Also during this period of strong stomach contractions, the rate of the heart beat is increased, and gradually returns to normal after their cessation, a point to be remembered in minor heart dysfunctions. The salivary flow also parallels these contractions, and each contraction is accompanied by a brisk gush of saliva from the parotid gland, which varies with the individual child.

RETARDATION OF THE GASTRIC CONTRACTIONS

It is important to know that the normal, healthy child's hunger urge can be restricted so as to fit his biologic food needs. Nothing is more irresponsible than appetite, for it can be called into play at any time, even following a hearty meal. The action of acids, or of liquids containing acids, including normal gastric juice, can cause the inhibition of the stomach mechanism. Such fluids influence a stoppage of the movements and of the tonus of the empty stomach, when directly introduced into it, and the duration of this inhibition is on the whole proportional to the concentration and to the total quantity of the acid introduced. Often 200 cc. of a three-tenths percent solution of hydrochloric acid will usually restrict the contractions for a period of twenty-five to thirty minutes. Advantage is taken of this fact in sickly children, for if a normal acid gastric juice, or the juice of a lemon, orange, or grapefruit be introduced during a relative resting interval of the stomach, the appearance of the contrac-

tions at the next hunger urge will be delayed, and if these fluids are introduced during the active contractions, the contractions are abolished or modified in strength. The duration of this inhibition by acids is probably determined by three factors; namely, the passing of the acid into the duodenum, the fixation and the neutralization of the acid on the mucosa of the stomach, and the neutralization by bile and by the intestinal juice, which at times passes into the stomach through the dilated pylorus. On the other hand, these hunger contractions are not inhibited by weak concentrations of acids. In most cases it is the hydrochloric acid in the child's gastric secretion which undoubtedly produces this inhibition. If, then, a child's food at the biologic periods of appetite and stomach contractions is sufficiently palatable, and the mastication of it is satisfactory, the inhibition of the stomach contractions produced reflexly from the mouth fuses with the acid stoppage from the stomach, and satisfaction and contentment take place. If, on the other hand, the food is not especially palatable, or if mastication is insufficient, the contractions may resume upon the ceasing of the chewing, and then again be inhibited for a time during the period of the most rapid secretion of the appetite juice. Gastric contractions in the child's stomach, while not affected by weak acids or by the normal gastric juice, cause an increase in the peristalsis of the intestines. Care must be exercised also in the use of medicines before meals which encroach too near the periods of normal hunger contractions. There are two drugs which have a relaxing and tone lowering influence on the smooth muscle structure; namely, benzyl benzoate and papaverine, which are found to depress the periodicity and the vigor of these contractions.

HUNGER AND APPETITE IN DISEASE

To the normal, healthy, hungry child, the admonition not to forget his table manners, not to "wolf" his meals, usually falls on deaf ears. The senses, keyed to the highest, respond to adequate, well chosen, simple, well prepared, and attractively served foods. Such foods fully satisfy the child's cravings. The sick child presents quite the reverse picture; he is suffering perhaps from an acute disorder, or recovering from a contagious disease or from a debilitating infection of long duration, from a gastrointestinal condition, or from maladjustments because of inherited dysfunctions. It cannot be denied that much infant mortality could be prevented through a scientific understanding of foods and infant feeding and a greater knowledge of bio-

physiologic chemistry. In the nutrition of children, the opinions of the laboratorian often disagree with those of the clinician. Laboratory findings follow along more or less prescribed paths; the clinician, on the other hand, views his work as more personal and rather empirical. Nowhere is this truer than in the diseases of children. A heightened or lowered metabolism rate shows a corresponding rise or fall in hunger and appetite sensations; a decrease in rate is frequently seen in disease, as in fevers of various origin, in anemias, in cachexias, and in uncommon types of the neuroses. In such rare conditions as diabetes, brain tumors, and certain forms of the neuroses, such sensations may even be stronger. On the other hand, in certain varieties of stomach disorders seen more frequently in older children, such as atony, gastritis, constipation, hypermotility, pyloric insufficiency, and vagotonia, these gastric sensations may be lessened. Therefore it is the responsibility of those treating disease in children through nutrition to carefully study all factors.

Theoretically, a failure to treat many of these cases successfully might arise from the following reasons:—first, a direct failure or absence of the tonus and hunger contractions of the empty stomach; second, a prolonged reflex inhibition of the stomach; third, the interference with or the depression of the central conduction paths; fourth, the direct depression of the cerebral or thalamic hunger centers; fifth, the interference with the central conduction of the hunger impulses by abnormal or by unusually strong impulses from other proprioceptors. These varied causes are induced by pathologic changes in the blood, in the motor mechanism of the stomach itself, or in the central conduction paths and sensory centers.

APPETITE PERVERSION

Once in a while there is seen a case of bulimia, or voracious appetite, in older children. It may be of temporary or of long duration, and is undoubtedly a dysfunction of hereditary origin, but usually amenable to treatment. The hunger desire comes on shortly after eating, and if not appeased by a well ordered diet, headache, weakness, or even moderate prostration, may result. Very small amounts of food will satisfy this abnormal hunger temporarily, but ingested food tends to leave the stomach more rapidly than normally. According to Nicolai, the condition is possibly due to the hyperexcitability of the afferent hunger nerves in the stomach and esophagus, and may be observed at times in young children suffering from excessive diarrhoea, from chronic

gastritis, and frequently from gastric hypersecretion. The onset is usually sudden, and nausea may follow even from the taking of small quantities of food. This abnormality must not be confounded with a perverted condition where there is appetite but no hunger, and which is often seen in the petted and spoiled children of the ignorant or newly rich. In older girls suffering from chlorosis there is often a desire for highly spiced or for acid foods. With many young children there may be a peculiar appetite perversion for clay, chalk, earth, which are eaten for their taste. It is usually, the writer believes, just a bad habit and has no relationship to pathologic mental processes. During colds, tonsilitis, and influenzal attacks, in rhinitis and in pharyngeal inflammations, the hunger contractions may be retarded and the appetite is often completely lost.

There are three interesting phases of gastric motility perversion which arrest the attention; namely, pylorospasm, contenital pyloric stenosis, and rumination—miserable heirlooms of heredity and often influenced by poor environment. Pylorospasm has been ascribed to a great variety of causes, including a primary neurosis of the local motor mechanism. The hyperperistalsis of the filled stomach is usually associated with spasms of the pylorus and may be merely a temporary condition, due to the presence of food in the stomach. If pylorospasm is simply a primary hypermotility of the entire stomach, the condition of hypertonus and of hypermotility should be also in evidence when the stomach is empty. Rumination in infants may or may not be related to pylorospasm.

STIMULATION OF HUNGER

The custom of stimulating the child's appetite through tonics of one kind or another is still a popular one. "Shot gun" prescriptions, which may include a melange of miscellaneous bitters, are employed, rather than rational biophysiologic methods. The value of bitter herbs in diseases of infants and children is very debatable and may possibly be limited to treatment of an impaired digestion of a mild or temporary form. The mechanism of this method is still in doubt and is, at the most, subjective. Indeed, the color and taste of these bitters may arouse a desire for them, psychically. Experience has taught that bitters, as generally employed in medicine, have no favorable physiologic action on the hunger mechanism; their therapeutic use, however, may still be justified to a limited degree by their direct action on the gastric secretion or on the appetite.

Carlson believes that these bitters induce hunger sensations in three ways:—first, through the increase of the hunger contractions of the empty stomach, or through the hastening of the reappearance of the gastric contractions, by facilitating gastric digestion through increased secretion or increased peristalsis and thereby accelerating the emptying of the stomach; second, possibly by increasing the appetite directly through the stimulation of the gustatory and other sensory nerves in the mouth, esophagus, and stomach, or indirectly by increasing the gastric digestion; third, strong efferent impulses from the mouth, perhaps from the esophagus and stomach, may in some way bring feeble hunger and appetite sensations more prominently into consciousness. In greater than therapeutic doses, however, these bitters inhibit and abolish the hunger sensations, through the stimulation of the nerve endings in the stomach mucosa.

HUNGER AND WATER

One of the most important biologic stimulants is water, for it exerts a decided action on the hunger mechanism of the stomach. Employed somewhat under identical conditions, orange juice, grapefruit juice, lemon juice, and the expressed raw juices of many berries have an added value in that they contain both vitamins and inorganic salts. Such physiologic substances allay the pain of gastric contractions in health and tend to extend the feeding periods in disease. Water at body temperature or when nearly ice cold tends to inhibit the tonus and the hunger contractions of the child's stomach, for when introduced directly in an amount of 100 to 200 cc., the cessation may last for three to five minutes and is never followed by an increase of the tonus or of the contractions. Very cold water, however, causes a greater inhibition than that of body temperature. If such contractions are very severe there may be no perceptible cessation, and food alone will give satisfaction. In other words, the degree of inhibition by water in the stomach is inversely proportional to the intensity of the hunger contractions present at the time of drinking it. Even water, warm or cold, taken between meals, during a period of relative stomach rest, does not increase the tonus or initiate a series of contractions, but rather inhibits their onset.

The only possible way that water can prompt the hunger contractions is apparently through the stimulation of the nerve endings in the stomach mucosa; (a) by mechanical pressure, (b) by osmosis, (c) by changing the chemical equilibrium of the stomach contents. It is well to realize that the cessation of this

contraction inhibition probably marks the passing of the water out of the stomach into the intestines—or else it is brought about by the addition of sufficient salts to prevent stimulation through hypotonicity. The alleged action of cold drinks on the stimulation of hunger and appetite is probably due to the reflex effects of cold from the mouth and esophagus. Such effects are, however, hard to prove.

All nervous, and neurotic children often exhibit a pseudo-appetite. Such children are inclined to fidget with their hands and feet, chew gum, or, in fact, any article which can be taken into the mouth. Finally, a suggestion to drink water or fruit juices on arising, or between meals, in order to stimulate peristalsis or to mitigate gastric pains until such time as the stomach contractions and the appetite desire fall into alignment, may prove of benefit.[2]

THIRST

The child's body, regarded as a self-regulating organic whole as far as its physiologic activities are concerned, is dependent upon three sources of supplies from the outside world:—(1) food, to provide for growth and repair, to supply energy, to promote a well ordered metabolism, and for the maintenance of body heat; (2) oxygen, to aid in the oxidation of substances without the cell; and (3) water, which acts as the medium in which occur all its chemical processes. A child may suffer from insufficient nourishment over a certain period of time without permanent harm to his body structures, but if oxygen is denied for even a brief interval, unconsciousness or death may follow. Certain nerve cells in the cerebral cortex, when totally deprived of this important element, cannot carry on their normal oxidative processes for more than eight or nine minutes without undergoing fundamental abnormal changes. Observers have remarked upon the fact that, while the pangs of hunger may cease after a short time, thirst has persisted until almost the last moment of life.

Normally, food, oxygen, and water are maintained within the child's body at a balance of the body needs. The food used in metabolism, in the normal functioning of the body organs, in growth, and repair must be restored, so that the oxidative processes may continue and the cells may have an adequate store of food upon which to draw.

The cell may hunger, may thirst, may become fatigued. Often it cries for food, fluid, and rest long before we sense it, while depriving itself of food storage through the oxidative processes

necessary to its activities. It is this constant in and out flow of food materials which keeps the cells in active health; to divide, to repair, to replace—in short, to function normally.[2] Oxygen is continually leaving the body with carbon and hydrogen as carbon dioxide and water, and is resupplied through respiration. Water, which is also being discharged constantly in expired air, is found in the secretion from the kidneys and in the sweat. Thus this constant water loss must be compensated by a fresh supply. Water-need is seen in nature also. The plant needs it for the metabolism of food elements within the seed. In the child's organism water is necessary for the digestive secretions, for cell oxidation, as a means of absorption in the composition of the blood and lymph, as a lubricant in association with other substances, as an aid in regulating body temperature, and for many other needs in health and disease.

Like hunger, thirst is controlled by a definite mechanism, as expressed in certain sensations and desires. While hunger and thirst are indispensable to the child's existence, they are not alike in their characteristics. Food remains for a definite time in the stomach and undergoes physiologic changes. Fluid, on the other hand, leaves the stomach rapidly through the nerve-muscular mechanism of its walls, and is thrown into the small intestine. The sense of satisfaction of thirst is not so keen as that of hunger. If the child's food is too dry and bulky to digest easily there may exist, coincidentally, a feeling of thirst. The clinician, therefore, must decide how much or how little fluid should be given at meals. Cannon suggests that the sensation of thirst may be referred to the mucous lining of the mouth and pharynx, to the root of the tongue, and to the palate, but these sensations are undoubtedly secondary. In some unexplained way, the cells of the body, some more than others, put forth a strong urge for fluid before their storage runs low and before their metabolic activities are interfered with.

Mayer places thirst-sensation in the list of changes which affect the central portion of the cell. In experiments upon the increase of the osmotic pressure noted in thirst, he was led to the conclusion that when the osmotic pressure of the blood rises above normal, thirst appears, but when the pressure returns to normal, thirst vanishes. When the pressure varies, thirst follows suit, but other agencies are present in the body tending to keep the blood normal. One may visualize a very thirsty child as having a blood of high osmotic pressure, a condition affecting all the cells of its body. Particularly does it affect the cells of the central nervous system and the circulatory reactions, in consequence of which

there is a strong desire to drink. Wettendorff suggested that the liquids bathing the cells would, in consequence, be the first to concentrate. Thus, as cellular life becomes so irregular, there is a serious call for fluid. Water is indeed an essential constituent of the cytoplasm of the cell. The constant loss of it in the urine, feces, perspiration, and in the expired air, would ultimately result in the drying-up of the body tissues and in the concentration of the body fluids, were it not for the sensation of thirst, which leads to the replacement of this water.

It is often necessary to distinguish between a true and false thirst in children. True thirst has already been discussed. False thirst is merely a temporary dryness of the mouth and pharynx arising when the flow of saliva decreases and the back of the throat feels dry. If, however, this condition is more than temporary, false thirst becomes true thirst and the cells call for water. False thirst is commonly seen in neurotic or nervous children and those suffering from adenoids, large tonsils, or other pathologic obstructions in the nasopharynx. The pleading of spoilt children for food and drink between meals is often due apparently to a pseudo-emotionalism fostered by the sympathetic nervous system.

BODY FLOODING

The logic of today appears to advocate a systematic overdosage of water upon the child's organism. Because a little pure water is beneficial it is thought that larger amounts should be even more so. Although in the ordinary life of an active, healthy child there is little to be feared from an excess of ingested water, in less favored children metabolic upsets are often seen. It is interesting to note that the drinking of large quantities of water during a prolonged period of fasting may affect the osmotic tension of the body fluids so as to cause an increased catabolism of the proteins, fats, and possibly of the carbohydrates. Such catabolic changes may act as appetizers, in that they produce enormous amounts of fuel in the rebuilding of a sluggish metabolism to new energy and power. In accounts of native uprisings we read of the water cure; that is, the forcing of large amounts of water down the throat for punishment, or to force confessions. In a less marked degree, this procedure is often followed with children. However, every child, ill or well, ingests voluntarily only as much fluid as his body craves, depending upon the amount of exercise, the time of year, the proper or improper functioning of his organs, upon the temperature of his body,

upon the kind of food he eats, and whether the food is dry or moist, salted or unsalted. The drinking of water in excess causes a sense of fullness, a loss of energy, a disinclination to play or of any form of exertion.

These symptoms may precede a distinct organic unbalance. Rowntree demonstrated that the administration of large volumes of water by mouth to dogs and to other animals induced intoxication leading to convulsions and death, although no pathologic findings were discovered at necropsy. Definite changes also may take place in the composition of the blood, for the ingestion of large volumes of water causes a significant dilution of the blood and of the serum-proteins. The salt content is reduced, the chlorides and sodium salts being decreased to a much greater extent than might be expected from the degree of dilution. This leads to the query as to whether the passage through the body of the child of such large quantities of water may not rob it of much of its salt content, and to such an extent that a resultant upset of the water-salt equilibrium may occur, with a consequent change in the ionic concentration of the cell. In the experiments of Underhill and Sallack, a marked and constant increase in the excretion of the chlorides, phosphates, ammonia, creatinine, and of the total acid content took place. The urinary excretion returned to normal only after the cessation of the water treatment. In their experiments, the blood showed a definite and constant dilution and its chlorides were diminished to a marked degree. So, too, were the tissue salts, with a consequent disturbance of the water-salt-equilibrium of the body.[2]

FATIGUE

Fatigue may be conveniently classified into three general divisions—physiologic, psychologic, and pathologic—all separate, and yet, paradoxically, all correlated. A specific biophysiologic form is known as chemical fatigue, which is closely associated with physical fatigue. These forms are analytical in nature and their classification is not generally understood. Each worker considers fatigue, whether of brain or muscle, from a different angle. Furthermore, each form of fatigue may be subdivided into severe, intermediate, and mild.[2]

PHYSIOLOGIC FATIGUE

Normal fatigue of both brain and body, like hunger and thirst, is one of life's natural protective reflexes, one of life's many

biologic prerogatives. It is a markedly important phase of childhood, and in the strong and active is transformed into a condition of health and energy through deep and refreshing sleep. The better hunger and thirst are satisfied, the better ordered the food and drink supply, and the better balanced the metabolism, the more refreshing is the slumber. Normal fatigue reflects upon the body organs, lowering their activities and powers of function. Sleep is a natural and positive function. When the energy of the body threatens to become exhausted through lack of food to the cell or from excessive physical and mental activity, this little body must be rejuvenated through food and sleep, for during sleep the cell intake is greater than its output. In order, therefore, for the cell to store up food, two needs of the child must be satisfied; namely, hunger and rest. Normal fatigue precedes strength, courage, audacity, and adventurous undertakings. It often follows sudden excitement, with a consequent expenditure of energy. In normal, healthy children fatigue is increased under excitement of pressure up to a certain point, then it seems to disappear suddenly and to reappear in psychologic fatigue or exhaustion. In the highly nervous and extremely fatigued child this does not hold good, for fatigue is long in coming and long in disappearing. The healthy child spends a part of his day in hard physical play or exercise, changing constantly from one form to another, if left alone. Physical exercise, almost to a point of over-exertion, is followed by brief intervals of rest in which restitution is rapid and complete. Such fatigue after play is biologic, but when rest and nutrition are unsatisfactory and the exhausted cells are not restored, the condition may become pathologic. In fact, the quality of fatigue is often dependent upon the correlation of the body organs and their harmonious functioning, or upon a maladjustment of these organs which may be attributed to hereditary influences.[2]

In older children, the problem of fatigue may be more complicated. Often it may arise when practically no physical or mental activities have come into play; and when the cells of the body are surfeited with food there may be an associated outpouring of energy. This form may be seen among pupils in school, sitting on hard benches or trying to perform unpleasant tasks or perhaps listening to the monotonous drone of an uninspiring teacher's voice. The child is soon overcome with fatigue. He gapes, his thoughts wander, he cannot follow the daily routine of work. The foul air of the schoolroom hastens and increases his weariness, and energy returns only when he steps out-of-doors. School work is badly done and the child remains after school to

make it up. Inferiority complexes develop, physiologic fatigue may be followed by psychologic, by pathologic fatigue, and by exhaustion, and suicide may result. Such states may be indicative of the child's growing mental abnormality. Normal fatigue has an energizing effect upon the child's mental and physical activities, but abnormal fatigue, as pictured in the schoolroom, has a depressing effect on cell-life and there follows a vicious reaction on the part of the central nervous system. Even in milder cases, the withdrawal of nutrition from the cell without proper rehabilitation through food and drink causes the organs and tissues to feel the deprivation, and physical lassitude and inertia may follow.[2]

Fundamentally, *physical fatigue,* resulting from muscular exercise, follows a series of contractions. In the healthy, energetic child the muscular contractions increase as the exercise continues, each contraction being a little stronger than the preceding one; they then grow less and less. During this time the latent period of muscle lasts longer, as do the periods of contraction and of relaxation; and in the last stages of fatigue the contracture passes off completely. Physiologic fatigue results and is present in proportion to the balancing of metabolism. The neglect to properly balance nutrition at such a time has a harmful effect on the blood. This may be demonstrated by the introduction of the blood of a fatigued animal into a less exhausted one, for such blood gives rise to all the symptoms of fatigue in the second animal, since it contains the products of severe muscular activity. It is possible that a partial inhibition of the central cells may result from certain impulses which pass up from the active muscles themselves, in which case the reflexes which follow may be dependent on the degree of fatigue present. In extreme fatigue, of a physiologic rather than of a psychologic nature, when a reflex can no longer be elicited the balancing of metabolism is seriously affected, as stimuli so necessary to brain stimulation and function are absent.[3]

CHEMICAL FATIGUE

Chemical fatigue is closely associated with physical fatigue, for chemical processes take place following physical exercise. When a child exercises his muscles are contracted, and blood sugar, or the so-called glycogen, is consumed in order to sustain these contractions and changed into lactic acid, a poison of the tissues. While normally the lactic acid is slowly washed away by the blood stream, yet even when the child exercises mod-

erately sometimes it accumulates in the muscles faster than it can be washed away. This accumulation of lactic acid is the chemical cause of fatigue. When a child uses but a small group of muscles an excess formation of lactates may be carried to other parts of the body by the blood stream. To prevent an excess accumulation and the insidious spread of lactic acid in the body, it is wise to have the child play games which provide periodic rests. The game of marbles, for instance, requires but little physical exercise, while cricket, baseball, football, hockey, and running demand constant contraction and relaxation of muscle groups.

Normal relaxation, in addition to rest and simple, wholesome food, are much more effective methods for health preservation than the continued curtailing of the child's natural release of energy through muscular activities. A more perfect recuperation can then be established by natural means, since the production of lactic acid is at its lowest point. For instance, the importance of putting the child to bed early in a quiet, well ventilated room, that he may enjoy a long night of restful sleep, tends to decrease the lactates to a marked degree.[4]

CHANGES IN CERTAIN BLOOD CONSTITUENTS FOLLOWING MUSCULAR FATIGUE

Muscular fatigue produces other important changes in the blood. Overindulgence in sports and other muscular exercise by an ill-conditioned child brings about changes, mostly chemical in character, which center largely in carbohydrate nutrition. Acidosis is an illustration of this point, for the plasma bicarbonate of those children overindulging in exercise is probably diminished rapidly at first, then more slowly. The first effect is due to forced inspiration, the second to an accumulation of a fixed acid. One should not forget that a difference in climate and altitude may produce different responses of the child's organism. Even at different temperatures there is a variance from a hyperventilation at high to a hypoventilation at low temperatures, and there arises the greatest accumulation of fixed acid when the surrounding temperature is, say, forty degrees.

Christensen found that the blood sugar decreased below the resting level at the beginning of exercise, but rose again at its cessation. He apparently discovered no connection between the blood sugar concentration and the degree of fatigue and no relation between body temperature, alkali reserve, and blood sugar level. Dische and Goldhammer discovered experimentally

that continuous strenuous exercise over a long period of time produced a fall in the blood sugar level and also a drop in organic phosphorus; the acid soluble phosphorus, however, being increased. From the laboratory standpoint one is left very much in doubt as to the various chemical events incident to acute fatigue under favorable as well as unfavorable conditions of nutrition. Clinically, the contrast is very much in evidence. After extensive exercise there is a fall in bicarbonate concentration which is less marked in healthy children than in the unhealthy.

After any form of exercise there is always a displacement in the acid-base balance of the child's body and in the direction of a carbon dioxide deficit, or else a loss in the direction of a fixed acid base. In any case, an increase in the serum lactate may be assumed, the rise being greater the more strenuous the exercise and the more severe the malnutrition.[5]

FACTORS GOVERNING SPEED OF RECOVERY FROM MUSCULAR FATIGUE

The biologic factors governing recovery from fatigue are of great importance. The muscular activity of a healthy child and the subsequent period of physiologic rest have a marked influence on metabolism and on its many activities, for a great amount of energy is expended in muscular movements. Fatigue following a great expenditure of energy is manifested not only by the need for oxygen but by a gradual slowing up of muscular activity, as seen in the isolated muscle, and should not be considered as fatigue of the central nervous system, which might occur later on. Biologic in character, it is due to a diminished speed of contraction and relaxation in the muscle. The kind of sport or exercise and the dissimilarity of physical constitution and condition of active children tend to produce a difference in the rate of circulation of the blood, beside consuming disproportional amounts of oxygen per kilogram of body weight. An efficient and increased blood circulation, laden with the products of proper metabolism which nourish the child's system, depends largely on the alternate pressure and releasing of the veins to propel its contents to the heart.[6]

If the two sartorili muscles of a frog are held in the pliers and the one placed in oxygen, the other in nitrogen and both are stimulated by the same succession of electric shocks in series, it will be found that the muscle placed in oxygen soon attains a steady level of contraction, while the other rapidly reaches com-

plete fatigue. The one dipped in oxygen assumes a condition in which the formation of lactic acid from glycogen is balanced exactly by the restitution of lactic acid from glycogen under the influence of oxygen diffusing in from outside. In the other no restitution is possible, and the muscle proceeds to liberate lactic acid and its increasing concentration finally puts an end to activity.[6]

The formation of lactic acid from glycogen during the activity of the muscle is the essential fact concerning the chemistry of contraction. In the absence of oxygen, the breakdown goes on until the accumulation of lactic acid raises the hydrogen-ion concentration to such an extent that further stimulation becomes ineffective. The result is fatigue. At the same time, an unstable organic compound breaks down with the liberation of inorganic phosphate, but what role the latter plays is beyond our knowledge. The lactic acid does not remain free in the fluid of the muscle but is rapidly and completely neutralized. The main part of the neutralization is carried out at the expense of the protein buffers, in part, however, at the expense of the alkaline salts. The initial heat in muscular contraction can be attributed to the formation of sodium or potassium lactate from glycogen, hence the necessity of a balanced metabolism in exercise-loving children. The lactic acid, once formed and neutralized, merely accumulates with continued stimulation in the absence of oxygen, until the slowly rising hydrogen-ion concentration finally stops the muscle completely. With oxygen, the acid disappears, while the glycogen from which it came is restored.[6]

PSYCHOLOGIC FATIGUE

Many effects of psychologic fatigue remain obscure, unfathomable, and elusive. Possibly some of these are seen in a lowered functioning power of the endocrin glands; the so-called autoprotective mechanism. Symptoms may be light or profound, but are often far-reaching. These and other glands producing enzymes and secretions of one kind or another are called upon to do excess work in fatigue. These organs are completely, or at least partially exhausted in their normal activities. In the abnormal condition of excessive nervous fatigue, and even to a greater extent in exhaustion, these juices are drained more slowly, and return more slowly to normality.

At no time, then, should one forget the intimate relationship of heredity to psychologic fatigue in the transmission of normal or of pathologic organ fundamentals. Fatigue, says McNulty,

"is an expression, as we use it today, of the under or exhausted functioning of these glands of internal secretion, or of the tissues," and the rational treatment, he adds, "is the employment of associated ductless gland substances, as they seem to be physiologically associated in the living normal organism." In this many of us cannot consistently concur, at least as regards children. It would seem impossible to expect of more or less synthesized products those favorable results over a long period which are produced by normal glands, whose rudiments form the origin of their hormones and whose development is brought about through metabolism and environment. A physical and physiologic environment consisting of proper nutrition, open air exercise, rest, bathing, and other factors, combined with a psychic environment of normal emotional excitement, are factors better able to activate endocrin function which tends to control the child's daily life than are the products which any scientific laboratorian can devise, however skillful he may be.

Normal mental fatigue follows physical fatigue whether it be light or severe. A disturbance of the natural physiologic processes is sure to react on the mental processes. Normal mental excitement is a stimulant to metabolism. An excess, however, causes bodily upsets which disturb physiologic processes. Normal mental activities are interrupted and relaxation of the mind is impossible. Nervous breakdowns follow. Many individuals do not know how to relax from physical or mental activities. Many older children unwisely draw on their emotional storage without replenishing it later. The Orientals and the Latins consistently take their daily siestas. Mild physiologic fatigue in susceptible children who lack emotional control may develop into a severe form of imaginary fatigue.[4]

DREAMS

From the physical and subsequent mental fatigue of the day, there occurs at night an emotional discharge in the form of dreams. Normally this occasions no worry, for they are but the safety valves of the child's emotional supercharge. Experience shows that with good ventilation and a properly made bed, with careful selection of night clothing, with no disturbances of radio, talk, slamming of doors, and other disturbances, and with a well proportioned and digestible meal at supper time, these discharges react in no way unfavorable to digestion and metabolism. Under unfavorable conditions and after severe chemical fatigue, light sleep takes the place of profound slumber and dreams are

on the rim of consciousness. Because of fatigue, subconscious ideas may awake to consciousness, and concepts formed in the preceding day or even in former years may develop into dreams. Light sleep tends to distort pleasant dreams into those which are unpleasant, while dreams arising from deep sleep only foster happy ones.

In dreams of children there is far more secondary elaboration than in those of their elders, and more overflow from their experiences. Children often gratify in their dreams some forbidden desire. Amid pleasant surroundings, dreams may take on a constructive aspect, a desire for accomplishing something in the succeeding day which may indeed prove a stimulant, an appetizer to metabolism. Different types of children have different emotional discharges. Elaborate and fanciful dreams are common with the imaginative, nightmares with the timid, and vivid dreams with the unstable. Children enjoy talking of their dreams and making them come to life. Environment affects boys and girls differently. Sweet dreams are enjoyed by the intelligent rather than by the unintelligent. Dream life may be an evidence of individual character and may represent repressed emotionalism. Dreams vary with age, health, disease, sex, poverty or wealth, proper or improper nourishment, with the deaf and dumb, and with normal or abnormal children. Dreams may be of educational value both to parents and children, in that they tend to throw light on special interests and desires at different ages. A dream may show the trend of the child's mind for learning, development, and for artistic or mechanical pursuits.[7]

PATHOLOGIC FATIGUE

The healthy, normal fatigue of a child after play is quite different from that following exhaustion, when metabolism becomes disordered and perverted. Fear, extreme sensitiveness, loss of ambition and of the fighting spirit, so necessary to childhood in both boys and girls, may succeed abnormal fatigue. In early childhood, exhaustion is usually only temporary, but in later years it may become chronic. It is associated, in many instances, with a lack of tone of the mental faculties, for an exhausted brain cell is unable to receive dynamic stimulations of a physical or of a psychic nature. Abnormal psychologic fatigue, when relatively mild in character, may arise often from lack of inspiration in the affairs of daily life. Admonitions to be little ladies or gentlemen, with all the attendant restriction, naggings and in-

hibitions, the prohibition of games and plays, the scarcity of play space often bring about strong mental reactions.

Normal fatigue, or mild forms of abnormal fatigue should not be confounded with severe exhaustion, yet the former may easily be transposed into the latter, while the reverse can never take place. The effect of exhaustion upon the biologic cells, and consequently upon the organism, may be profoundly depressive. It is noticeable, at times, that a child buoyed up by intense emotional excitement, such as fear or anger, may have no feeling of fatigue. However, after this psychic force has spent itself extreme exhaustion may follow. During such periods there is a terrific strain on the cells of the body. Often in nervous and neurotic children, suffering from a faulty heritage, fatigue may follow from only moderate physical or mental strain and may quickly turn to exhaustion. Severe neurotic symptoms may develop, such as headaches, backaches, constipation, indefinite pains in arms and legs, horrible dreams, and fantastic unrealities. In extreme cases of nervous exhaustion the metabolism is markedly disordered and mental apathy results.

To a certain extent, normal fatigue in children is controlled by the will, while abnormal fatigue is not. In the latter case the child too often loses interest, does not respond after rest to pleasure and health, whereas after normal fatigue the reaction is strongly apparent. For such neurotic children public school is unthinkable. It is far better to send them out in the open air to play, that they may become really hungry for food; but at the same time their food must be carefully supervised. All difficult and uninspiring school work but paves the way to mental invalidism. Labelled by their parents as good little boys and girls, neurotic children often possess unnatural characteristics which the normal little rascal does not. They are usually obedient, often careful in their habits and in their dress, possess beautiful table manners, have a high sense of duty and of responsibility, and are sensitive to the worthiest reactions. Such children are not queer, nor are they mentally unbalanced, unless judged by their more mischievous associates. Nor must they be confused with normally nervous children, who are often creative, energetic, affectionate, ambitious, perhaps thoughtless, but who develop into great men and women.[2]

FATIGUE IN SCHOOL CHILDREN

From a critical and clinical standpoint, fatigue, specifically in school children, is physical, physiologic, and mental, and it may

also be acute or chronic. Acute fatigue in the well nourished, or indeed in the illnourished child, occurring temporarily, produces no evil consequences. It is in those chronic forms, both mental and physical, in school children which command the attention. Chronic fatigue may in many instances have some connection with the inheritance of a dysfunction, or it may be purely somatic in character. Under improper treatment chronic fatigue may reach into adult life and eventually result in mental or physical unfitness, or both.

Thornton fittingly expresses the physiologic aspect. "Chronic fatigue," he says, "has many and various manifestations. The outstanding symptom of anorexia is due to a food intake entirely inadequate to meet the needs for growth and repair. A vicious circle is created, the small amount of food consumed resulting in weakness and fatigue, and the greater the fatigue the less desire for food. Stationary weight or loss in weight is the inevitable sequence of diminished food intake."

Physical and mental objective symptoms may be seen, such as listlessness, sluggishness, timidity, moroseness, physical tire, mental inertia, manifold nervous symptoms, whining, a lack of interest in home affairs. There may be characteristic physical abnormalities of the hair, skin, eyes, and of the musculature. A slouching attitude, round shoulders, lordosis, scoliosis, and a prominent abdomen may arouse suspicion. Nervous reactions may appear, such as irregular muscular contractions, restlessness, or unrefreshing sleep. Insomnia, flushing or pallor of the skin, and signs of emotional instability may be present. Possibly the child's general condition is first noticed when the report card from school shows an inability to concentrate, a supposed laziness, and a lack of interest in the work, resulting in low grades.

Since in the pubertal period the body develops more quickly than the brain, the fatigued child is biologically unable to grasp the purpose of his school work, and perhaps finding himself under an uninspiring teacher, soon develops a retarding inferiority complex which further restricts his mental and physical progress. Suffering from this unfortunate complex he soon becomes moody, irritable, unhappy, and retiring, an anti-social introvert. Somatic disturbances may from time to time add to this mental submersion and disrupt the metabolic processes. One cannot pass lightly over inherited potential dysfunctions or such physical conditions as adenoids, enlarged tonsils, carious teeth, improperly erupting teeth, anterior and posterior cervical gland enlargement, faulty eye and ear conditions, and other

remediable pathologic somatic disturbances. The lowering of discipline in the home has developed a perverted sense of life's realities which bring about irrational conduct in the child, resulting in a sense of fatigue. The changed home life, the cinema, the women's clubs, etc., have turned the parent's minds to outward rather than to closer home surroundings, and children have suffered. Mental and physical fatigue in the school child may follow from uncongenial tasks quite unfitted to his talents. Singing, instrument playing, speaking in public are some of the more disturbing factors which lead themselves to fatigue.[8]

METABOLISM AND FATIGUE

Cell metabolism specifically exerts a marked impression upon fatigue in all its forms, and fatigue likewise reacts on metabolism. The urge of the cell for proper food is drastically made known by the organs, in the deference of function and of energy output.

Probably one of the most common forms of physiopathologic fatigue is that associated with gastrointestinal intoxication following an excess ingestion of animal proteins, particularly of meat and eggs. The products of this decomposition, indol, skatol, and many others, are classic examples of so-called fatigue substances. These two, with phenol and the cresols, arise from bacterial activity on protein matter in the intestine, and are absorbed. In many cases, and under proper nutritional treatment, their toxic effects are reduced in the child's organism by their conjugation with sulphuric and glucuronic acids.

To summarize:—Thirst, hunger, and fatigue are nature's fundamental driving forces, which, with properly balanced environmental factors, help to control and maintain metabolism, thereby stimulating mitosis, growth, development, and repair in the child's organism. If these three propelling factors are denied, the functioning capacity of the organism is lowered. The vitamins, proteins, fats, inorganic salts, and carbohydrates are often unduly lauded in nutrition, while the foods containing these substances and their motivating factors are, in contrast, not given their proper recognition. Normal fatigue, followed by sufficient rest, is one of life's best health restoratives, but an overstress of body and brain, which result in pathologic conditions, are some of the most vicious adversaries of health.

In the large cities, malnutrition in school children can often be traced directly to herding, faulty hygiene, improper selection and preparation of food; but indirectly it may be caused by lack of relaxation and insufficient rest. Many children expend more

energy during the day than they have stored up during the previous night, and more than can be restored by the amount and kind of food which they eat or by the short time spent in sleep in the succeeding day and night. Underweight and undernourishment result. Even if they are taught the necessity of rest and relaxation, the yoke of poverty often deprives these children of the facilities with which to carry out prescribed teachings. The ultimate benefits resulting from recreation, rest, and relaxation in children are often unrealized. Given proper nourishment and rest, freedom from unnecessary restrictions by elders, happiness in play and pleasures, there follows the call of hunger and thirst, and the outpouring of large amounts of secretions and hormones from the endocrine glands and from the organs of digestion. The period of recovery from fatigue varies with different children. In healthy children, it may be only a few hours; in children with an inherited dysfunction, the recovery period may be longer.[2]

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